STEM
COLLABORATIVES

CREATING A UNIFIED COMMUNITY OF SUPPORT:

Increasing Success for Underrepresented Students in STEM

A Final Report on the CSU STEM Collaboratives Project

By Adrianna Kezar and Elizabeth Holcombe

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ABOUT THE AUTHORS

USC PULLIAS CENTER FOR HIGHER EDUCATION

With a generous bequest from the Pullias Family estate, the Earl and Pauline Pullias Center for Higher Education at the USC Rossier School of Education was established in 2012 (the center was previously known as the Center for Higher Education Policy Analysis). The gift allows one of the world's leading research centers on higher education to continue its tradition of focusing on research, policy, and practice to improve the field. The mission of the Pullias Center for Higher Education is to bring a multidisciplinary perspective to complex social, political, and economic issues in higher education. Since 1996 the center has engaged in action-oriented research projects regarding successful college outreach programs, financial aid and access for low- to moderate-income students of color, use of technology to supplement college counseling services, effective postsecondary governance, emerging organizational forms such as for-profit institutions, and the retention of doctoral students of color.

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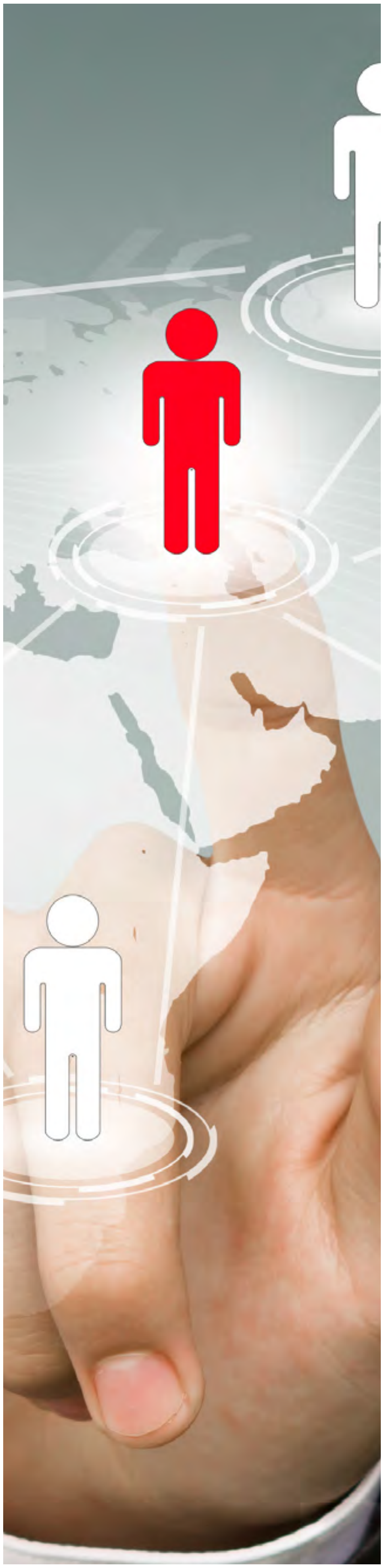

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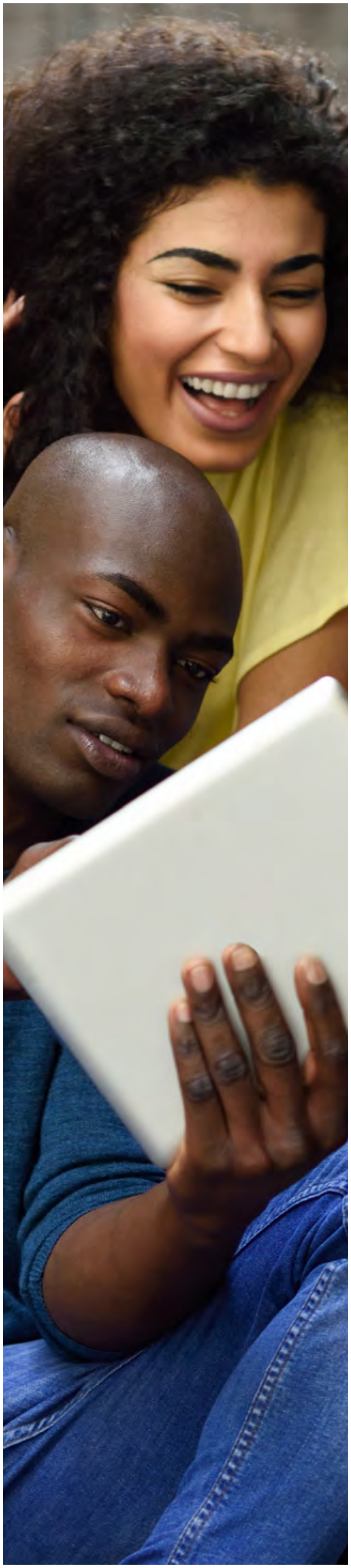
EXECUTIVE SUMMARY

This report discusses the findings from a three-year study of the California State University STEM Collaboratives project, funded by the Helmsley Charitable Trust. The project selected eight CSU campuses to rethink the ways in which they support first-generation, low-income, and underrepresented minority students in science, technology, engineering and math as they transition to college and experience their first year. Each participating campus implemented three integrated high-impact practices, or HIPs, through collaboration among faculty and student affairs. The three HIPs were a summer experience, a first-year seminar or first-year experience, and redesigned introductory STEM courses. Below are the key takeaways from the mixed-methods case study that examined project implementation across all eight sites. For recommendations on how campuses, state higher education systems, policymakers, and funders can act on these findings, please see Chapter 8 of the full report.

1. Elements of underserved, STEM student success are locked into separate silos—academic affairs and student affairs—that almost never connect, which leads to the creation of interventions that almost always meet only half of the demands that underserved, low-income, and underrepresented minority students in STEM face. What our study identified is the importance of academic and student affairs working together to develop interventions that use the knowledge that exists amongst both divisions and can help lead to STEM student success.
2. We found that the specific interventions matter less than the integration of multiple support programs. Having multiple, connected HIPs is beneficial, regardless of the type of HIP.
3. The study and project identified the importance of a unified community of support that can break the typically negative climate that many first-generation, low-income, and URM students face in STEM. A unified community of support brings together the knowledge of academic and student affairs to develop the appropriate interventions for students, to create multiple touch points of support and relationships, and to establish a community that is there for students as they encounter challenges. What single interventions (or even multiple disconnected interventions) typically fail to create are the kinds of ongoing communities, relationships and touch points that are needed.
4. Cohorting students into the same shared experiences and courses developed a strong sense of belonging for students. Some campuses found data to support this increased sense of belonging. Cohorting students and aligning programs in general represent new ways of working in higher education, as opposed to the prevalent "cafeteria college" model identified by Bailey, Jagger, and Jenkins (2015) in which courses, majors, and support programs are all disparate and unconnected.
5. For all the value that the STEM Collaboratives program had for students, it also had a great value for faculty, staff, and the broader campus communities at the participating CSU campuses. Creating an integrated program for STEM students led to numerous positive outcomes for the campus community, including building relationships, learning about other faculty members' work, learning about student affairs work, learning more about the students served, learning about needed institutional support and practices for supporting first-generation college students, improving first semester courses in terms of engagement and discussion, providing community for faculty (particularly part-time instructors), and conducting joint work such as new grants, new curricular initiatives, and redesigned courses.



6. The value added for faculty and staff then cyclically also supports students. Relationships, learning, and mutual respect, better experiences for faculty, and joint work all facilitated the development of a unified community of support among faculty and staff on the CSU campuses, which positively supported student retention and outcomes.
7. One of the most valuable lessons learned from the campuses was the identification of key mechanisms that can help facilitate alignment of the programs including a thematic approach, professional learning communities, a STEM center, pathways or structured curriculum, and advising and technology systems.
8. Collaboration is the most important aspect of a smooth implementation process. Collaboration is critical to a sound design for integrating the three HIPs, important to the planning team in terms of supporting a strong planning process, tied to buy-in, and responsible for helping change agents navigate institutional policies and practices that get in the way of aligning the programs, such as prohibitions against block scheduling. Collaboration is an important facilitator, but it was also a significant barrier if not approached in the appropriate manner.
9. The greatest facilitators beyond collaboration were: appropriate program design that matched campus needs, strong team composition and relationships, ways to address workload and time for collaboration, navigation of policies and practices that typically hinder integration and alignment, differentiated communication strategies for different groups, a project coordinator or similar role to connect various team members, and effective evaluation of the multipronged program to provide data that demonstrates success.
10. The most significant barriers to implementation included workload, competition among support programs, poor relationships between academic and student affairs, lack of knowledge about other units and their work, poor program designs that did not include an understanding of student needs or did not include existing programs, and poor team composition.
11. Survey results show that some of the barriers to implementing HIPs or pedagogical change in general are like the implementation challenges for integrated programs. Two sample findings are that: A. No campuses support instructional improvement through annual merit pay, and B. There are few classrooms and facilities on campus that promote the kind of evidence-based, active pedagogies that support the most student learning.

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FOREWORD

Effective and Inspiring: A New Way to Introduce STEM in College

The February 2012 report of the President's Council of Advisors on Science and Technology (PCAST)[1] included some troubling observations. It forecast a serious shortfall in the country's supply of science, technology, engineering and math (STEM) graduates—more than a million fewer than the anticipated demand. And the predicted STEM workforce isn't just too small; it's also too homogenous and lacks diversity in ethnicity, gender, socioeconomic status, and parents' educational attainment.

In seeking an abundant and diverse supply of students to fill the gap, the Council of Advisors reached incriminating conclusions:

- In the United States, fewer than 40% of the students who enter college with the intention of majoring in a STEM field complete a STEM degree. Most of the students who leave STEM fields switch to non-STEM majors after taking introductory science, math, and engineering courses.
- Many of the students who leave STEM majors are capable of the work, making the retention of students who express initial interest in STEM subjects an excellent group from which to draw some of the additional 1 million STEM graduates.
- Many students who transfer out of STEM majors perform well, but they describe the teaching methods and atmosphere in introductory STEM classes as ineffective and uninspiring.

In other words, the students we needed to meet the forthcoming STEM field demands were already on our campuses, and *had already declared majors in STEM*. But their first taste of it was so off-putting that they left soon afterward.

The findings struck a nerve in the California State University System. We enroll more than 400,000 undergraduates—the largest and most diverse student body of any public, four-year system. And we are a major source of the state's—and nation's—STEM graduates, as our 23 campuses include a maritime academy and two polytechnic universities.

Most of our universities are access-oriented and only moderately selective. Many of our students choose us over state flagships and will succeed no matter what; but for many others, we represent the best opportunity to earn a degree, and adequate academic support is crucial.

So, it seemed that if someone was going to respond to our country's need for STEM graduates, then it should be us.

In responding to the national call for more STEM graduates, we drew on lessons learned from several earlier projects—funded by agencies and philanthropies such as the National Science Foundation or the W.M. Keck Foundation, organized by national associations such as the Council on Undergraduate Research, or simply driven by local experimentation.

An initiative led by the Association of American Colleges & Universities' *Project Kaleidoscope* and funded by the Keck Foundation was an especially helpful launchpad.[2] It pulled together a cross-divisional set of system and campus leaders to build a system-wide "framework" for STEM student success interventions and mapped the pockets of strength as well as needs across multiple campuses as they stood on the eve of CSU STEM Collaboratives, the project described in this report.

Because it drew on so much earlier work, many people across the CSU System participated in the Keck-PKAL framework project. Among the shifting participants a few

[1] https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf
[2] https://www.aacu.org/pkal/educationframework; http://search.proquest.com/docview/1698320234?pq-origsite=gscholar

stood out, listed here with their roles at the time:

- Beth Ambos, Assistant Vice Chancellor, Research Initiatives & Partnerships, CSU Office of the Chancellor
- Susan Baxter, Executive Director, CSU Program for Education and Research in Biotechnology (CSUPERB)
- Juanita Berrena and Lisa Hammersley, Directors, The California State University Louis Stokes Alliance for Minority Participation (CSU-LSAMP)
- Judy Botelho, Director, CSU Center for Community Engagement
- Susan Elrod, Executive Director, Project Kaleidoscope (AAC&U)
- Jeff Gold, Senior Director of Academic Technology Services, CSU Office of the Chancellor
- Krista Kamer, Director, CSU Council on Ocean Affairs, Science & Technology (COAST)
- Wayne Tikkanen, Director, CSU Institute of Teaching and Learning

At the end of the process, one recommendation from the campuses rose to the top: Don't keep incentivizing, funding or adding new STEM student success interventions. Instead, give campus leadership a way to integrate and institutionalize the effective programs they'd already developed on their campuses. This wasn't just a caution, but a call for help.

That understanding of our next step arose in the context of a new systemwide focus on student degree completion, the CSU Graduation Initiative. In 2009, the Chancellor and Presidents committed the system to dramatic improvements in six-year graduation rates and pledged to cut in half the difference in those rates between students of color and others. The high-level, high-profile direction lent new urgency to student success in STEM, where so much ground had to be covered.

During discussions with Ryan Kelsey at the Leona M. and Harry B. Helmsley Charitable Trust, we added a handful of program parameters to assure early STEM immersion and institution-wide impact. The main purpose was to leave behind the sinkhole of "ineffective and uninspiring" introductory courses and allow students to practice and identify as engineers, mathematicians, and scientists as soon as they arrive on campus. An integrated, introductory STEM experience would be immersive and exciting, but with no loss of educational power—in other words, effective, engaging, and inspiring.

At the time, I led the department of Student Engagement at the CSU Office of the Chancellor. Nominally the Principal Investigator, I relied on a broad team that included the leadership of the Keck-PKAL Framework project, a full-time project manager during the run of CSU STEM Collaboratives, and a panel of distinguished national advisors. But above all we took our cues from the leadership teams at each of the eight participating CSU campuses, whose work is reported here.

What we learned from them was this: Universities can improve the odds for low-income, first-generation students who major in STEM, when the effort is sustained, concerted, and campus-wide. We moved the needles we set out to, not because we picked the right individual programs or interventions, but because campus teams collaborated across the divisions of academic and student affairs to create a community of integrated support. That patience, bridge-building, and sheer hard work changed the trajectories of thousands of students—and of campus culture—and is outliving the grants.

I encourage the readers of this report—especially academic leaders, student affairs administrators and faculty working at all levels of our universities—to look at how specifically the participating campuses managed and created integrated educational experiences for STEM students. There are ideas you can use right away, and uncovering them was our biggest reason for launching the project.

Finally, particular thanks go to the tireless writers of this report. We all benefited from the insights and full participation of our research partners along the way, Adrianna Kezar and Elizabeth Holcombe of the University of Southern California. They worked alongside the participating campus teams, embedded themselves in the national network of Helmsley grantees, and produced the findings you have here.

Ken O'Donnell
CSU Dominguez Hills

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CHAPTER 1:

1

Introduction and Overview

More California State University students are declaring an interest in science, technology, engineering, and math (STEM) majors than ever before, but nationally only about 40% of students who start college as STEM majors graduate with a degree in STEM within 6 years; students from historically underrepresented backgrounds lag even further behind (President's Council of Advisors on Science and Technology, 2012; Eagan et al., 2014; National Academies, 2016). While there are numerous support programs for STEM students in the CSU System, they tend to target specific, limited populations of students and remain disconnected from one another and from other support programs for low-income, first-generation, or underserved students. Additionally, many of the existing support programs have not included or not coordinated with efforts to redesign introductory STEM courses. As the largest institution of public higher education in the state of California, with increasing populations of students of color, low-income students, and first-generation college students, the CSU has a vital opportunity to improve the ways it supports STEM students, especially those from underrepresented backgrounds.

The CSU STEM Collaboratives project, funded by the Helmsley Charitable Trust, was a three-year project designed to integrate a series of High-Impact Practices (HIPs) to better support first-year STEM students both inside and outside the classroom. Consisting of a summer bridge program, a first-year experience, and redesigned introductory STEM courses, the STEM Collaboratives project also aimed to bridge traditional divides between student affairs staff and faculty members, all of whom have crucial roles in supporting student success in STEM. Coordinated at the system level through the Chancellor's Office, the STEM Collaboratives project was designed to evaluate these integrated interventions at eight individual CSU campuses, while also building a community of learning and support across the project sites.

This report provides a research *summary of the project's outcomes and draws lessons from across all eight project sites.* In this chapter, we present some of the research on STEM education and the context for these interventions. In Chapter 2, we provide an overview of each of the eight projects, as well as a description of our study methodology. Chapter 3 presents the value of the STEM Collaboratives program for students and for the broader campus community. In Chapter 4, we describe what underrepresented students need to be successful in STEM and cover key lessons from both student affairs staff members and faculty who participated in the project. In Chapter 5, we present a more detailed picture of two especially successful, yet very different campus projects: FUSE at Dominguez Hills and the Klamath Connection at Humboldt. Chapter 6 elaborates on the role that collaboration played in the project. In Chapter 7, we review some of the challenges to implementation that are unique to these types of integrated programs and we conclude with key takeaways and recommendations in Chapter 8.

It is our hope that the lessons in this report will benefit stakeholders at other institutions and organizations who are interested in collaborating across departmental and unit boundaries and aid them in rethinking the ways in which they support first-year students in STEM, especially those from traditionally underserved backgrounds.[3]

STEM Education and Context for Interventions

Before discussing the results of the STEM Collaboratives project, it is important to understand the existing context and need for rethinking support for STEM students in higher education, especially in the first year of college. This section: (1) provides an overview of challenges in STEM higher education, both nationally and at the CSU (2) describes existing efforts to support both STEM students and student success more broadly at the CSU, and reveals gaps in support; and (3) briefly explains the components of the CSU STEM Collaboratives project.

OVERVIEW OF CHALLENGES IN STEM EDUCATION

As demand for workers in science, technology, engineering, and math fields continues to grow, stakeholders in government, industry, and education have become increasingly concerned that institutions of higher education are unable to meet this demand with a proportionate supply of college graduates in STEM. Over the next decade or so, there will be 1 million new jobs in STEM fields, yet the number of STEM graduates has remained fairly stagnant (PCAST, 2012). This stagnation is not due to a lack of interest in STEM; more entering college freshmen declare an interest in STEM majors than ever before. However, nearly half of the students nationally who start in STEM fail to complete their degree in STEM (Eagan et al., 2014). Students from low-income families, historically underrepresented racial/ethnic groups, or who are the first in their families to attend college can face even steeper obstacles when pursuing a degree in STEM. While 46% of White and Asian-American students majoring in STEM complete a degree in 6 years, less than one-third of Latino students, just under one-quarter of Native American students, and just over 20% of African-American students completed a STEM degree within 6 years (Eagan et al., 2014; National Academies, 2016). STEM students in the CSU system fare slightly better than national trends, but similar gaps remain. Throughout the system, students from low-income backgrounds are only three-quarters as likely to graduate within six years with a degree in STEM (45% vs. 59%), and under-represented minority students only two-thirds as likely (40% vs. 61%) (www.calstate.edu/dashboard).

Despite the decades of focus and effort invested into fixing this problem, attrition from STEM majors remains high, especially during and after the first year. And despite the increased numbers of underrepresented minorities (URMs) entering higher education and STEM majors in particular, attainment of STEM credentials among these populations remains low. Why is this challenge so pernicious and persistent?

STEM attrition is a complex problem, with many contributing factors that must be considered together. In general, the transition from high school to college and the first year of college can be extremely challenging, especially for students of color, first-generation college students, or any students who did not receive adequate academic preparation in high school (Terenzini & Reason, 2005). Students may lack key foundational skills or knowledge that professors in STEM courses expect, especially in math (Astin & Astin, 1992; PCAST, 2012). Further, introductory courses in STEM are not structured to help

[3] Underrepresented minority (URM) students are the majority of students on many CSU campuses, so the system uses the term underserved. We use the term URM to refer to racial and ethnic minorities that historically have been underrepresented on campuses and in STEM. URM would still apply to CSU students in STEM. We sometimes also refer to these students as "students of color." Throughout the report we use these terms interchangeably, though we recognize they may have slightly different meanings in different contexts. We also refer to various other underserved populations throughout this report, including low-income and first-generation students. To avoid repetition throughout this report, we may use only one term in some places (i.e. URM, low-income, or first-generation), but all of these groups were served by STEM Collaboratives and our major points are meant to be inclusive of all groups.

students compensate for this lack of preparation. Instead, they are designed to weed students out, often through competitive grading policies or messaging from faculty members about who belongs in science or who deserves to continue (Seymour & Hewitt, 1997; Wao et al., 2010; Christe, 2013). Additionally, these introductory courses frequently cover an enormous amount of material quickly, superficially, and through lecture-based instruction that is not engaging or supportive for students (Fairweather, 2008; Austin, 2011; Seymour & Hewitt, 1997). Introductory courses often lack real-world connections or authentic scientific experiences, other than lab sessions led by teaching assistants. Students often do not have exposure to these real-world connections or authentic scientific experiences until their junior or senior year. Sadly, this is too late for many students, as most who leave STEM decide to switch majors or drop out after taking an introductory STEM course (PCAST, 2012; Seymour & Hewitt, 1997).

These introductory courses are one aspect of what researchers have identified as a negative climate in STEM, which is characterized by a sense of competition rather than community, (Palmer et al., 2011; Marra et al., 2012; Hurtado et al., 2010); faculty who are perceived as “indifferent, uncaring, or unapproachable” (Seymour & Hewitt, 1997, p. 124); and an unsupportive environment in which students struggle to get academic or career advice, accurate information on courses or sequencing, and help in understanding material (Seymour & Hewitt, 1997; Gasiewski et al., 2012). Faculty may not cultivate a sense of belonging or openness, staff support (such as advising) is often perceived as inadequate, and peer support can be minimal because of the competitive culture. These problems are all exacerbated for populations traditionally underrepresented in STEM: women, students of color, low-income, and first-generation college-goers (Hill, Corbett, & St. Rose, 2010; Palmer et al., 2011; Hurtado et al., 2010; Strayhorn et al., 2013; Strayhorn, 2015).

MANY EXISTING INTERVENTIONS BUT SIGNIFICANT GAPS IN SUPPORT

Over the last several decades, colleges, universities, foundations, and national organizations have experimented with a variety of interventions to improve these negative experiences for underrepresented students in STEM. To address problems with introductory courses, campuses have experimented with curriculum and instructional reform, as well as undergraduate research, tutoring support, and partnerships with learning centers. To combat the broader negative climate in STEM, they have tried interventions such as mentoring, summer bridge programs, career counseling and awareness, workshops and seminars, and enhanced advising (for a detailed overview, see Tsui, 2007). At the CSU, ongoing efforts to support STEM students include the Minority Engineering Program (MEP), Maximizing Access to Research Careers (MARC) from the National Institutes of Health, Hispanic-Serving Institutions (HSI)-STEM, Louis Stokes’ Alliances for Minority Participation (LSAMP), Research Infrastructure for Science and Engineering (RISE) from the National Science Foundation, STEM Engaged Learning, (STEM)2, TRIO Student Support Services (SSS)-STEM Health Sciences, as well as numerous campus-based programs and STEM Education Centers. These programs have long histories at the CSU and have demonstrated success with the students they serve. However, most serve only small numbers of students and are often isolated from the overall campus. Many provide significant support only after the freshman year, and none address the curricular changes that are so critical to STEM student success.

The CSU does have a history of supporting innovation in curricular and course redesign, but it has been disconnected from other STEM support initiatives. For example, the system operates initiatives such as Early Start, which offers the opportunity to take an in-person, online, or hybrid accelerated course in the summer before their first year to students who need remediation in English or math, and Course Redesign with Technology, which helps faculty redesign bottleneck courses using evidence-based pedagogies and technologies. Additionally, in 2014, the system provided funding to several campuses to experiment with scaling HIPs.

While there have been numerous interventions, no programs at the CSU have connected existing interventions into an integrated approach and incorporated both curricular innovation and out-of-class support for first-year STEM students on a large scale—until the STEM Collaboratives. It is also unique as it is a program that supports student success as well as faculty and staff professional development.

What is the CSU STEM Collaboratives?

The CSU STEM Collaboratives was designed to build off the existing work of the system and its individual campuses in supporting student success, both in STEM and more broadly. The project's aims were to encourage campuses to rethink the ways in which they were supporting their first-year students in STEM, with an emphasis on supporting students from underrepresented backgrounds by integrating interventions for greater impact. The idea was to create a comprehensive program that would support students inside the classroom, through pedagogical reform of introductory/gateway STEM courses, and outside of the classroom, through mentoring, advising, tutoring, or other support programs; these supports would begin in the summer and continue throughout students' freshman year. The first year was targeted because many students leave STEM in the first year and few STEM interventions have previously been aimed at the first year. While these individual reforms (course redesign, mentoring/advising/tutoring programs, summer experiences) existed in various iterations and pockets at the CSU campuses, they had not been intentionally linked or integrated on multiple campuses (outside of small federally-funded grant programs) to create a comprehensive environment of support for STEM students in their first year. Also, programs often had a general student success aim and were not targeted to the specific needs of STEM students. Through linking several high-impact practices aimed at supporting students' growth and development, it was hoped that the STEM Collaboratives program could target the complex array of factors pushing students, particularly underrepresented students, out of STEM fields.

This program was designed to fill a gap in support for STEM students by focusing on their first year of college. It was not intended to create just another standalone or isolated program, or to be the magic silver bullet solution to the challenges of STEM higher education. Rather, the hope of this program was that in integrating curricular and co-curricular supports and bringing together faculty and student affairs staff, students would experience a more seamless and integrative support system during their first year in STEM. Further, the intention was to build connections to support students in their first year that would spiral outwards to encompass existing programs that support STEM students in their later years. The STEM Collaboratives program was intended to be just one piece of the larger pipeline of support programs for students in STEM, from freshman year to graduate school.

Audience

We see several audiences who will find value in the findings and insights of this report. First, *leaders of all types—administrators, faculty, student affairs staff*—on CSU campuses will identify how to create a unified community of support that fosters student success for those who have traditionally been the hardest to reach—low-income, first-generation, and underserved students. The report articulates the value of creating integrated programs that link faculty and student affairs staff who work with first year students through communication and collaboration. Additionally, leaders can learn about a model of collaboration that can help facilitate the development of a community of support, and increase their understanding of the implementation supports and challenges to creating that community.

Second, we envision *leaders on other campuses who are interested in supporting low-income, first-generation, and underserved students in STEM* as another audience for this report. While some of the implementation issues might be specific to the CSU system, the elements of support needed for STEM student success, the concept of the unified community of support, and the value of an integrated program will be important at any campus and transcend context. And we imagine some of the implementation issues will also be relevant for and translate to other campuses as well.

Third, the *CSU Chancellor's Office and other system offices* are another audience for this report. As system priorities, policies, and resources flow from the system office, the findings in this report can help to guide future priorities, policies, and resource allocation. Some of the issues we identify as implementation barriers and facilitators can be addressed by the system office (in conjunction with campus leaders). We provide recommendations in the final chapter that are specific to the system office.

Our final audience is composed of *national funding agencies* ***such as the National Science Foundation, National Institute for Health,*** Department of Education and other entities such as the National Research Council aimed at supporting success among STEM students. An enormous investment has been made in increasing the success of STEM students, particularly that of underrepresented minorities and first-generation students. This report outlines a wholly novel approach to STEM student success, aimed at the first years of college where a very high percentage of the dropout occurs. Previous funded initiatives and studies have focused on "silver bullet" or single interventions such as undergraduate research. This report identifies a very different approach to student success by creating a unified community of support that brings faculty and student affairs staff together to support students holistically. This finding is reinforced by recent reports by the National Academies of Science, (National Academies, 2016) on how to support 2-year and 4-year students through STEM. This national report identified the need for support throughout a student's career in STEM in transitioning to college, in introductory courses, and through the major. It suggests that culture change and system support are needed rather than single and isolated interventions. It is time for a new approach to STEM student success, and we describe the value of and approach to creating a unified community of support that does just that.

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CHAPTER 2:

Description of the Eight CSU STEM Collaboratives Campus Projects and Study

As described in Chapter 1, the STEM Collaboratives program asked participating campuses to link at least three high-impact practices (HIPs) and create an integrated program to support STEM students in their transition to college and during their first year. Specifically, each STEM Collaboratives campus was tasked with implementing some form of summer experience, first-year experience, and redesigned introductory or gateway courses for STEM students. Campuses were encouraged to partner with existing programs and offices wherever possible to avoid creating new boutique programs that would be unsustainable. All the campuses' programs could and did look very different based on their student population and their individual identification of the most pressing challenges for their own STEM students. The three interventions themselves looked different at each campus and some campuses added additional HIPs or programmatic components. In this section, we provide an overview of the three required interventions based on definitions from the research literature and then describe each campus' STEM Collaboratives program in order to provide a common base of understanding for the rest of this report.

High-impact practices (HIPs) are teaching and learning practices that have been proven to promote student success and retention. HIPs are effective because they promote several student behaviors:

1. Investing time and effort
2. Interacting with faculty and peers about substantive matters
3. Experiencing diversity
4. Responding to more frequent feedback
5. Reflecting and integrating learning
6. Discovering relevance of learning through real-world application (Kuh, 2008, p. 14-17).

The American Association of Colleges and Universities (AAC&U) has identified 10 HIPs: first-year seminars and experiences, common intellectual experiences, learning communities, writing intensive courses, collaborative assignments and projects, undergraduate research, diversity/global learning, service-learning/community-based learning, internships, and capstone courses/projects. However, Kuh (2010) notes that "there are other educationally powerful conditions that may well be worthy of the label 'high-impact,'" such as summer bridge programs or course redesign (p. ix).

2

Three Required Interventions

The first required intervention was a **summer experience** designed to help STEM students transition to college. This type of summer experience is more commonly known as a *summer bridge program*, which is a “program that occurs between high school and college that seeks to transition students to the college environment through academic activities” (Sablan, 2014, p. 1037). Generally, a summer bridge program includes some type of academic skill-building (either remediation or a head start, through credit-bearing courses, developmental courses, or workshops) as well as some college knowledge and affective/social/emotional skill development. Summer bridge programs often feature both faculty and student affairs staff working together to facilitate the experience. Most summer bridge programs last between two and six weeks, though some of the STEM Collaboratives campuses created shorter programs.

The second intervention was a **first-year experience (FYE)** or **first-year seminar (FYS)** to continue support for STEM students into the fall and spring of their first year. An FYS is a course, usually credit-bearing, that is designed to transition first-year students to college academically, personally, and socially (Tobolowsky, 2008). An FYE is a “comprehensive and intentional approach to the first college year…[that] comprises both curricular and cocurricular initiatives” (Hunter, 2006, p. 6). An FYE can include an FYS but has also been more broadly defined to include such things as orientation, welcome week, common readings, advising, supplemental instruction (SI), undergraduate research, learning communities, service-learning, and residential education initiatives. Given its broad, inclusive definition, this intervention varied the most at different STEM Collaboratives campuses.

The third and final required intervention was **redesigned introductory/gateway STEM courses**, which were intended to ameliorate some aspects of the negative STEM climate associated with coursework that has traditionally driven students away from STEM. A course redesign involves rethinking key course objectives, learning outcomes, intentional inclusion of evidence-based teaching practices such as active learning in course planning, and professional development for instructors (Eddy & Hogan, 2014; Gentile et al., 2012; Nomme & Birol, 2014; Russell et al., 2015; Thompson & McCann, 2010; Zwickl, Finkelstein, & Lewandowski, 2012). Redesign often means moving away from lectures and more traditional teaching methods and including more engaging course activities and assignments. It can also mean working to connect course content to more real-world problems or issues. The STEM Collaboratives campuses redesigned a variety of different courses, from calculus to chemistry. Some campuses had existing redesign efforts they could build from and redesigned multiple courses, while others had little experience with redesign and included only one redesigned course in their programs.

These interventions were intended to be integrated with one another to provide a seamless, cohesive experience for students. This meant that students were supposed to go through all the interventions together, and that the interventions should have meaningful connections and not just coexist. They could be integrated in many ways, such as through a theme, a pathway or structured curriculum, or a professional learning community for faculty and staff, among others (see Chapter 4 for more information about how campuses integrated their interventions). This integration was predicated on collaboration among the faculty and student affairs staff necessary to implement the interventions.

Campus Project Descriptions[4]

In this section, we provide brief descriptions of each STEM Collaboratives program on the eight funded campuses. Each campus came up with a name for its program aside from STEM Collaboratives; we may use those names interchangeably with STEM Collaboratives throughout the rest of the report as we provide examples from campus programs. Campus descriptions are presented alphabetically.

[4] Some language from project descriptions was taken from campus’ original project proposals and quarterly reports; facts and figures are from proposals, campus websites, http://www.csumentor.edu/campustour/ and http://www.calstate.edu/value/public-good/index.shtml

CHANNEL ISLANDS, RISE
(Retaining, Inspiring, Supporting, and Engaging Students in STEM)

CSU Channel Islands (CSUCI) is the newest of the 23 CSU campuses. Located in Camarillo in Southern California, it is small (enrolling fewer than 6,000 undergraduates) and has mostly commuter students. Of its students, 45% are Pell Grant recipients and 70% are non-white.

The RISE program consisted of an existing summer bridge experience called the Summer Scholars Institute (*summer experience*), small learning communities between a STEM course and general education courses called Freshman STEM Academies (*FYE*), and a redesigned first-year seminar (*redesigned course*). The Summer Scholars Institute (SSI) was a small grant-funded program that began on campus in 2012. It was a non-residential program that ran for three weeks and consisted of science activities, math workshops, and transition-to-college activities. About 25-30 students participated in SSI the over the two summers of the RISE program. Students who participated in SSI were recruited to participate in the Freshman STEM Academies.

The Freshman STEM Academies were the vehicle for CSUCI's FYE and redesigned courses. These learning communities linked a STEM course (either beginning algebra, intermediate algebra, or introductory chemistry) and an English composition course. In the first year of the program, a redesigned critical thinking FYS course (UNIV 150) was also included as a part of the learning community, but it was dropped for the 2016 academic year. This UNIV 150 course was the only course that the CSUCI team officially redesigned; originally a more traditional FYS course focused on college success/college knowledge, whereas UNIV 150 was altered to include a focus on scientific thinking. Instructors from the other linked courses met occasionally to discuss course content and had an informal theme of sustainability that they tried to bring into their courses when possible, but their courses were not formally redesigned. Instructors of linked classes also met to discuss student progress in their courses and to troubleshoot problem areas or coordinate assignments. Students enrolled in the STEM Academies also participated in supplemental tutoring/mentoring sessions. Seventy-nine students participated in the first 2015 cohort and 27 in the second cohort.

DOMINGUEZ HILLS, FUSE
(First-Year Undergraduate STEM Experience)

Dominguez Hills (CSUDH) has one of the most diverse and one of the most high-needs student populations in the CSU system. Located south of Los Angeles, CSUDH enrolls just under 11,000 undergraduates. In the CSUDH student population, 88% of students are non-white, 73% are first-generation college students, and about two-thirds are eligible to receive federal Pell Grants. Dominguez Hills is primarily a commuter campus, and many students work off campus to support themselves and/or their families.

The FUSE program was composed of several different variations of a summer experience based on student need, as well as linked redesigned courses with peer-led team learning (PLTL) sessions. Their *summer experience* ran parallel to

CSUDH's existing Early Start/Summer Bridge program in Year 1 and was more coordinated with this program in Year 2. The components of the summer experience included a 3-hour kickoff session for students and parents, which provided an opportunity to meet faculty and learn about club, internship, and scholarship opportunities; two 3-hour workshops for students called STEM 0, in which students met faculty, learned about STEM careers, and had a hands-on STEM experience; two math courses to give students a head start on precalculus (six weeks) and mathematical modeling (two weeks); and a computer science course that offered an introduction to programming (two weeks). These varied experiences were developed because the CSUDH team members determined that their STEM students were beginning college at wildly different levels of academic preparation and readiness; thus, a one-size-fits-all summer program would not be appropriate. Approximately 150 students participated in some aspect of the summer bridge program.

The *first-year experience* at CSUDH consisted of paired/linked courses that had been redesigned to include more active learning pedagogies, standards-based grading, and team-based learning. Additionally, the redesigned sections included PLTL sessions. PLTL sessions are weekly workshops hosted by more experienced students to support student success in a course. The courses that were linked included a common math course with either computer science or chemistry, depending on students' majors or preparation levels. These courses picked up on topics/themes that had been covered in summer sections of math and computer science, and common faculty taught the courses in both summer and fall. Approximately 155 FUSE students enrolled in these linked courses, along with some additional non-FUSE students.

CALIFORNIA STATE UNIVERSITY EAST BAY

EAST BAY, SUCCESS
(Supporting Undergraduates through Collaboration, Care, and Empowerment to Succeed in STEM)

Cal State East Bay, serving the Eastern counties of the San Francisco Bay area, has more than 13,000 undergraduates. Like Dominguez Hills, East Bay serves a very diverse student population, with more than 80% of it student body identifying as non-white and around half eligible for Pell Grants.[5] Students also come to East Bay underprepared, and more than half of incoming students need remediation in either math or English, and 40% require remediation in both.

The SUCCESS program changed significantly from Year 1 to Year 2. In Year 1, the summer experience was integrated into the existing Educational Opportunity Program (EOP) Summer Bridge Program, which ran for five weeks. SUCCESS students participated in a biology course, a math course, a college knowledge course, and a field study at the Port of Oakland. The Port theme was also brought into the biology course. Twenty-two students participated in the Year 1 Summer Bridge. Only 11 of those students ended up participating in the SUCCESS program during the academic year. The FYE in Year 1 was a Freshman Learning Community (FLC) called Diversity of Life, which consisted of three introductory biology courses across the three academic quarters. One of these courses had already been significantly redesigned through a previous grant. All courses in the cluster offered supplemental instruction (SI)—a weekly workshop taught by older students who had previously been successful in the course.

Because of the challenges with recruiting and retaining students in Year 1 of the program, in Year 2 the East Bay team decided to change several elements of SUCCESS. First, the team members decoupled their program from the EOP Summer

[5] http://www.csumentor.edu/campustour/undergraduate/9/csu_east_bay/csu_east_bay5.html

Bridge and created the SUCCESS Summer Academy, which was lasted four days and corresponded with other orientation events for students in various Student Equity and Success programs on campus. Instead of coursework, the Summer Academy in Year 2 featured workshops and opportunities to meet peers and faculty members. The connection with the Port of Oakland was dropped because of time constraints. A second Freshman Learning Community, STEM Pathways, was also added in Year 2 for students needing significant remediation and not yet eligible to take the biology courses in the Diversity of Life cluster (FYE). Instead, students in the STEM Pathways community took introductory biology, chemistry, and physics courses that were redesigned with active pedagogies or a studio model (redesigned courses). Forty-five students participated in the SUCCESS program in Year 2. East Bay also had an existing Institute for STEM Education, which provided staff and resources to the SUCCESS program.

FRESNO STATE
Discovery. Diversity. Distinction.

FRESNO STATE, CSM FYE
(College of Science and Mathematics First-Year Experience)

Fresno State is the largest four-year institution in Central California's San Joaquin Valley, one of the state's agricultural hubs. The University enrolls about 21,000 undergraduates and is both a Hispanic-Serving Institution and an Asian American and Native American Pacific Islander-Serving Institution. Just under 80% of students are non-white, nearly three-quarters are first-generation college students, and more 60% are Pell Grant-eligible.

The STEM Collaboratives program at Fresno is called simply FYE, and it serves students in the College of Science and Mathematics. The summer experience at Fresno is a four-day program with a mix of hands-on activities, experiments, problem-solving, and information sessions staffed by faculty, student affairs staff, and peer mentors. Some of the activities were related to a theme of sustainability, which cut through some of the academic year activities, as well. In Year 1 of the STEM Collaboratives 139 students participated at Fresno State, and 122 participated in Year 2. The first-year experience consisted of connected redesigned courses in the fall and spring semesters. The courses were team-taught and interdisciplinary, and included many hands-on and team-based activities and experiments, as well as links to the sustainability theme. Each class was centered around a specific project; in the fall, it was the socioenvironmental impacts of coffee and in the spring, it was on-campus sustainability concerns. Additionally, each course had two instructional assistants (upper-division science students) who led Supplemental Instruction (SI) sessions. The Fresno team also worked closely with the Advising Resource Center (ARC) to strengthen STEM advising and connect with other student affairs and student support services offices, such as career services, the learning center, the library, and the writing center. Additionally, they had two STEM VISTAs (Volunteers in Service to America), who helped support students, faculty, and staff in the program and developed service-learning opportunities for students. STEM VISTAs are part of an AmeriCorps program managed and funded at the system level; VISTAs help build capacity on campus to support success of underrepresented students in STEM. Fresno also had existing faculty learning communities called FLOCKs (Faculty Learning for OutComes and Knowledge), and funding through National Science Foundation (NSF), which it partnered with to promote faculty buy-in and learning about active pedagogies.

FULLERTON, ASCEND STEM
(Academic Success through Curriculum Enhancement and Nurturing to promote Degree completion in STEM)

Cal State Fullerton is one of the larger CSU institutions. Serving just over 33,000 undergraduate students, Fullerton is located in Orange County in Southern California and is a Hispanic-Serving Institution. Just under 80% of undergraduates are non-white, just under 50% are Pell Grant-eligible and 57% are first-generation college students. Like Cal Poly Pomona, Fullerton is one of the more selective CSUs, with an average entering GPA of 3.58.

The ASCEND STEM program partnered with the College of Engineering and Computer Science (CECS) and the College of Natural Sciences and Mathematics (CNSM) to offer a summer experience during New Student Orientation and linked redesigned introductory courses. The one-day summer experience involved orientation sessions, advising, a summer research exposure or summer design project, and registration for courses. The summer research/design experiences were hands-on projects performed in labs with faculty members. Approximately 280 students participated in the summer experience in Year 1.

The ASCEND STEM experience consisted of a newly designed CNSM 100 course, Introduction to Learning and Thinking in Science and Math, or an existing EGGN 100 course, Introduction to Engineering (redesigned courses). Depending on students' majors, they enrolled in one of these courses. The courses included active, experiential, and team-based components. The CNSM course was co-taught and included peer mentors. The EGGN course had four faculty members from each of the engineering departments who rotated through and each taught a four-week segment. Both courses had a paired 1-credit reading section, which supported scientific literacy, reading, and writing. And both courses were linked to other courses in a newly developed General Education Pathway called Science, Technology, and Society, which served as the FYE and was intended to create an integrated experience for students. This GE Pathway was designed to help students take courses that are thematically coherent and count directly for major or general education credits. Other courses in this pathway included a basic writing course, a public speaking course, and a critical reading course, all of which were modified to focus on STEM-related topics and meet the learning goals of the pathway (redesigned courses). Students also took the Effective Lifelong Learning Inventory (ELLI) in the summer and throughout the semester to learn about their own learning process and how they can improve certain skills or tendencies to become more effective learners. Fullerton had an extensive history of redesigned courses prior to the ASCEND project, as well as a thriving Supplemental Instruction program, which ASCEND students were able to benefit from once they got into their major courses.

HUMBOLDT STATE, KLAMATH CONNECTION

Humboldt State is a unique CSU campus, both academically and geographically. Serving about 8,000 undergraduates, Humboldt has a significantly higher percentage of STEM students than the average CSU (36% vs. 23%) and offers degrees in STEM programs such as Forestry, Environmental Science, Fisheries Biology, and Wildlife Management, as well as more traditional STEM fields like Chemistry and Physics. Humboldt is also the most geographically isolated of all the CSU campuses, located in a rural area several hours north of San Francisco. As a result, more students live on and around campus than at many other CSUs. While the surrounding area is mostly White, student demographics at Humboldt more closely mirror state-wide averages and other CSUs, with more than 50% non-white students and just under 60% Pell Grant-eligible.

These unique characteristics led to the creation of the Klamath Connection program, a place-based learning community organized around the theme of the nearby Klamath River Basin. Humboldt's summer immersion experience was a four-day residential program that included fieldwork, science assignments, and experiments all related to the Klamath River theme. In Year 1, there was also a section of the summer immersion group that went camping. However, the Humboldt team decided to discontinue the camping experience, despite students' enthusiasm for it, because outcomes were not significantly better for students who went camping versus those who stayed on campus and ventured out into the field only during the day. Sixty-three students participated in Year 1 and 118 participated in Year 2.

All students who participated in the summer immersion experience were enrolled in the Klamath Connection learning community during the academic year (FYE). The learning community consisted of linked courses that had been redesigned so that their content reflected and connected with the Klamath theme. Students enrolled in a major-specific FYS course that included typical University 101 activities such as time management, as well as major or career-specific content. Ten additional courses were redesigned and incorporated into the learning community: botany, two semesters of precalculus, communications, two semesters of chemistry, Native American studies, wildlife conservation, natural resource conservation, and an introductory forestry critical-thinking course. In Year 2, the team added four additional redesigned courses in environmental engineering, fish conservation, and English (two semesters). Students were block-enrolled in courses together based on their majors, though some sections did have non-Klamath Connection students in them. There were also Supplemental Instruction sessions in the botany and chemistry courses.

Additional parts of Humboldt's FYE included partnerships with the existing RAMP (Retention through Academic Mentoring Program) mentoring program to provide peer mentors for all Klamath Connection students and with Residence Life to create a Klamath Connection Themed Housing floor. This floor has its own classroom, where faculty were able to come and facilitate study and review sessions for students. The program also sponsored several extra- and co-curricular activities such as film screenings, tribal art exhibits, research talks, and social events.

Cal State LA

LOS ANGELES, FYRE
(First-Year Experience at ECST)

Cal State Los Angeles (CSULA) is a commuter campus located in East Los Angeles that serves approximately 24,000 undergraduates. Like Dominguez Hills, the campus is very diverse and serves a high-need student population; over 90% of students are non-white and nearly 75% are Pell-Grant eligible.

The FYRE program at CSULA serves students in the College of Engineering, Computer Science, and Technology. FYRE partnered with the College's existing NSF-funded STEP program to provide a seven-week Summer Bridge program that included math coursework, Supplemental Instruction, and college knowledge workshops (summer experience). The Summer Bridge was staffed by faculty, student affairs staff, and peer mentors. In addition to the Summer Bridge, students in FYRE were clustered into the same course sections, which included three quarters of calculus, two quarters of physics, and an introductory engineering course (FYE). While the physics and calculus courses themselves were not redesigned, all sections featured Supplemental Instruction. The introductory engineering course was redesigned to include hands-on activities, such as building an underwater remote-controlled vehicle, and Mathemagics, a set of activities designed to help students relate physical processes to their mathematical descriptions. Thirty-one students participated in the first FYRE cohort.

The CSULA team also developed a new advising tool called the Golden Eagle Flight Plan (GEFP), which helps students tie together various curricular and co-curricular experiences and includes milestones for both cognitive and dispositional learning. The GEFP began as a paper tool and eventually became a web-based and mobile app that students could use with their advisors or independently.

Additionally, CSULA was one of the few campuses to create a Professional Learning Community (PLC) for faculty, student affairs, and administrative staff members involved in educating STEM students. Though it only lasted for the first two years of the project, the PLC encouraged conversations across divisions and departments about best practices, student data, challenges, and opportunities for collaboration and eased some of the logistical implementation challenges that the team faced.

CAL POLY POMONA

POMONA, STEM SUCCESS

Cal Poly Pomona (Pomona) is a large STEM-serving institution located in the greater Los Angeles area. It is one of two polytechnic universities in the CSU system and one of the more selective institutions in the CSU system. More than 40% of its nearly 21,000 undergraduate students are engineering or science majors. Around 80% of its students are non-white and 51% are Pell Grant-eligible.

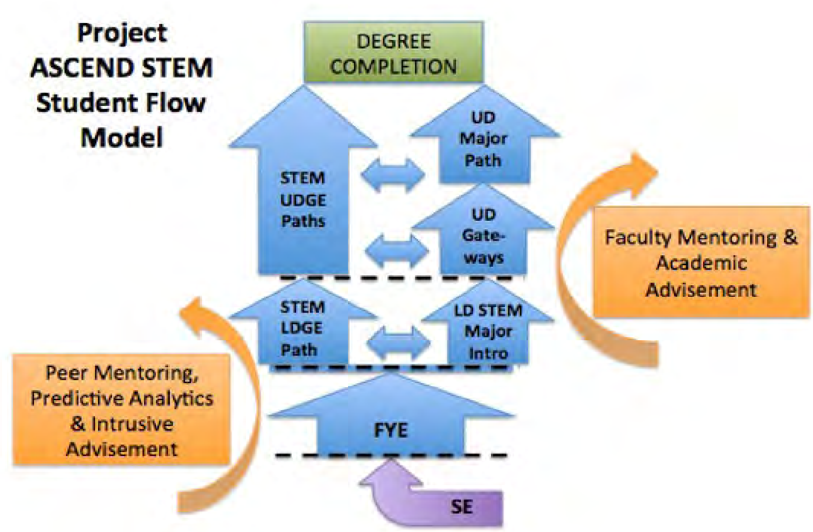
Pomona's STEM Collaboratives program underwent some significant changes over the grant-funded period. Initially called "Strengthening the Foundation for STEM Student Success," in its first year the program consisted of an enhanced orientation program for STEM students (summer experience), a new, intro-level, first-year seminar featuring STEM project-based learning as well as some co-curricular STEM activities (first-year experience), and redesigned math courses (redesigned courses). For its summer experience in Year 1, the Pomona team pulled approximately 100 STEM students out of the mandatory three-day summer orientation programming for sessions on STEM-specific topics. These topics included an overview of STEM-specific campus resources, registration for courses, and discussions of academic and career aspirations, as well as social activities designed to promote community among incoming STEM majors. Pomona's first-year experience in Year 1 consisted of a 4-credit, project-based course (CPU100L, STEM in Your Future) modeled after an existing engineering course, as well as several co-curricular activities such as Freshman Friday (out-of-class, project-based learning activities involving robotics), peer mentoring, and STEM cultural affinity groups. Pomona's course redesign in Year 1 focused on its remedial and introductory math sequence. The Pomona team implemented Learning Assistants and co-requisite remediation models in these courses, which were designed to help students learn more and get into college-level math more quickly. In the lowest-level math courses, Algebra and Trigonometry, a 1-credit Learning Assistance (LA) section was created. Based on an existing model in the Physics department, the LA section allowed students dedicated time every week to work on problems and get extra help from upper-division students. The team redesigned a pre-calculus course so that it could be taken concurrently with Calculus I; this co-requisite model of remediation boosted students' math skills while also allowing them to get into Calculus more quickly, thus removing an obstacle to progress toward their degree. Approximately 87 students participated in the FYE and redesigned courses in Year 1.

Based on evaluation results, the Pomona team decided to completely redesign the project in Year 2, giving it a new name as well (STEM Success). In Year 2, the project included a larger summer experience serving all incoming STEM students, approximately 2,000 students. Called STEMpire, this new summer experience eliminated information sessions and instead used games and competition to build community among STEM freshmen. The team is also redesigning a new, two-quarter sequence of courses to create an interdisciplinary course using a forensic science theme (redesigned courses). Additionally, they created a “Shark Tank”-style competition, in which small teams of STEM students put forth science- or engineering-based ideas to solve societal problems, and an online library of short videos providing advice and information to STEM students.

Examples of Project Logic Models

In their initial proposals, each campus created a logic model that was a visual representation of the relationship between their project’s goals, activities, and outcomes. We include several sample logic models here to demonstrate visually the ways that various campuses conceived of their project (Fullerton, Humboldt, and Dominguez Hills).

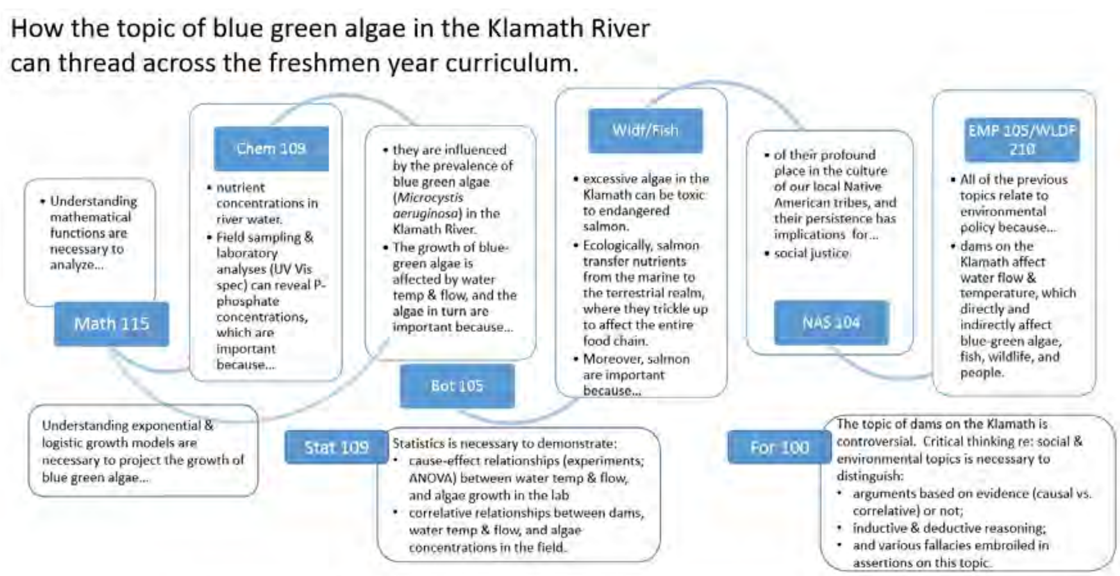
FULLERTON, ASCEND STEM



Fullerton’s model demonstrates how the team members envisioned their project fitting in with other campus initiatives over time, ultimately leading to degree completion.

Build an inclusive place-based learning community

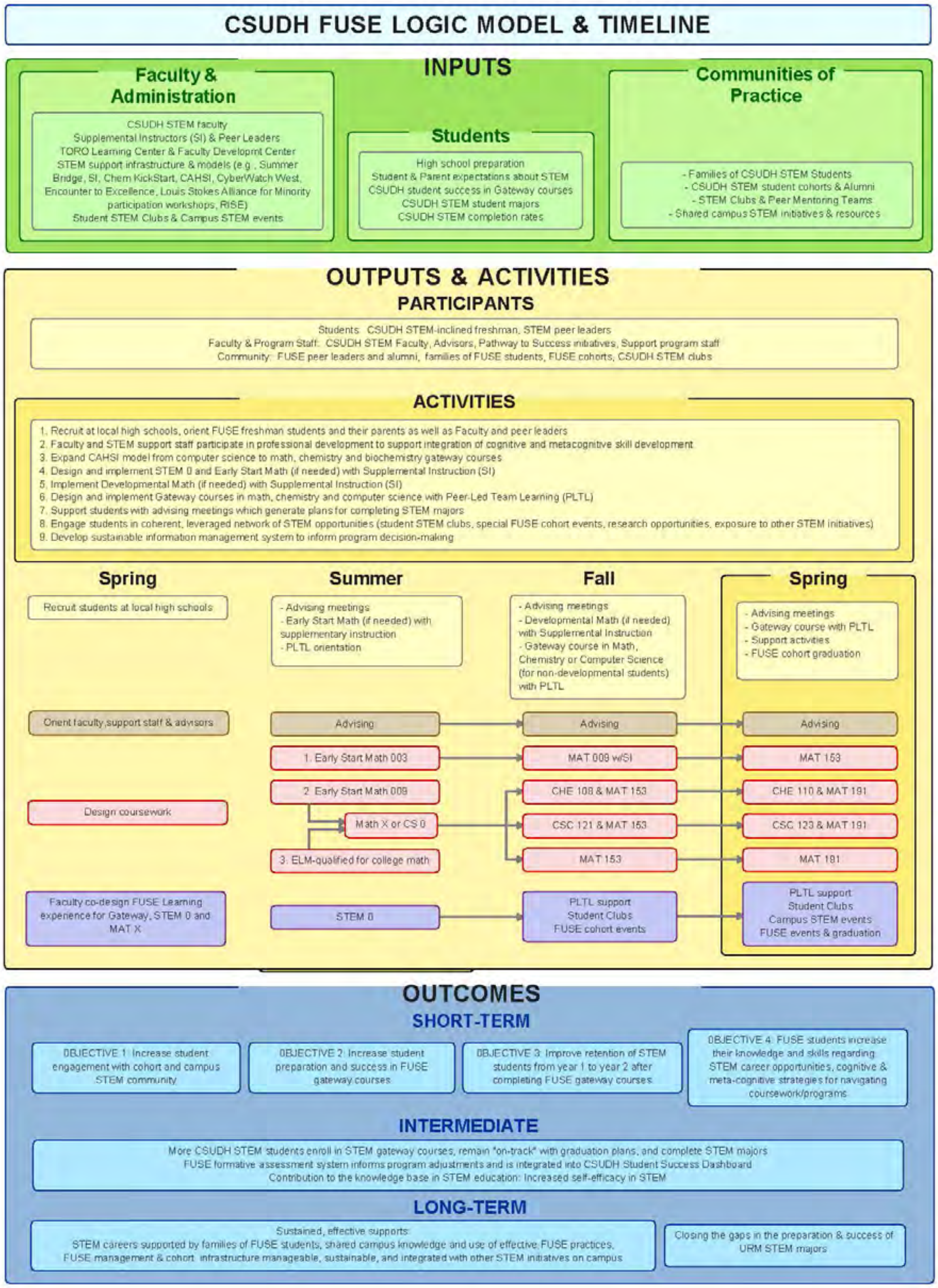
Hypothesized cause-effect chain resulting from a place-based learning community, leading to the ultimate goal of improved retention and graduation rates.



An illustration of how a single topic within a *place-based theme*, in this case blue-green algae in the Klamath River, can be woven across the freshmen year curriculum

The model from Humboldt has two figures and shows the broader logic behind its project as well as a specific example of how its place-based theme could be infused throughout the curriculum.

DOMINGUEZ HILLS, FUSE



The Dominguez Hills model is much more detailed and provides specific examples of its project's expected inputs, activities and outputs, and outcomes.

Not every campus team's final project looked exactly like its original logic model because of ongoing assessment and revision; nevertheless, we believe these graphics are helpful for understanding the projects and the planning process.

Study and Methodology

This study was conducted using a multi-method case study approach (Stake, 2005). Case study is often used to study implementation of a project or initiative and was thus an appropriate methodology for STEM Collaboratives. Additionally, case study often uses multiple methods of data collection to build understanding and strengthen interpretation of findings. For these case studies, we used surveys, document analysis, observations, interviews, and focus groups to collect data on the projects as they were planned and implemented. This data collection occurred in real time as the campuses developed and enacted their programs and followed campus teams' work over the life of the grant.

SURVEY

The study began with a survey of each of the eight campuses to identify how individuals perceive the campus context and its support for first-generation, low-income students, and URM students as well as for these types of students within STEM disciplines. In addition, the survey examined the values and attitudes of faculty and staff toward supporting first-generation, low-income students, their values and attitudes around teaching, as well as the existing practices that support teaching and student success more broadly. The survey was administered to the planning team, faculty, and staff in the departments in which the initiative was being implemented, as well as a sampling of faculty and staff across departments that were not involved in the initiative. Two years later, the survey was administered again, after the program had been administered to the first cohort and in the middle of conducting the second cohort, to identify if there had been an alteration in values or structures in support of student success and faculty and staff practices. Our initial survey went out to 1,291 individuals across the eight campuses; 627 people completed the survey, for an initial response rate of 49%. In the follow-up, 497 people representing 38% of the initial sample or 79% of the baseline sample completed the survey.[6]

DOCUMENT ANALYSIS

We asked the campuses to complete reflective quarterly reports with a set of 12-15 questions that changed slightly from the planning phase to implementation. We received eight quarterly reports from each campus. Questions included: what discussions took place among their teams; what progress was made toward developing or implementing their plans; how data was used to inform their planning and implementation; what surprises or adaptations resulted from implementation; what were barriers and facilitators of implementation; how they collaborated across units and departments; how they ensured integration of the three interventions; how they made progress on their evaluation plans; what policies needed to be adjusted to support the plan; how the campus and CSU system office could help support implementation; what challenges or concerns they wished to share; and what else they learned since the last report. We analyzed responses each quarter and used this analysis to guide our observations, site visits, and interview questions.

We also analyzed evaluation studies conducted by individual campuses about their interventions. The campuses conducted formative and summative evaluations of their projects, some using professional evaluators and some using colleagues on campus with knowledge of educational or social science research. Summative evaluations generally focused on retention, performance in next courses, conceptual knowledge in specific field areas, and psycho-social measures such as sense of belonging and academic self-efficacy. Formative evaluations provided satisfaction (and other experience-based) surveys of

[6] We do not spend much time in this report discussing survey findings, as there was very little change in survey indicators over the course of the project. This lack of change does not mean that change was not happening; rather, respondents scored very highly on the baseline survey in terms of their knowledge and self-reported use of evidence-based teaching practices and beliefs about what it takes to support STEM student success. These early findings made us question our assumptions about faculty knowledge of and engagement with research-based teaching methods and high-impact practices at the CSU and directed our attention to some of the structures and policies that either reward or inhibit faculty members' ability to act on this knowledge and beliefs (see the box on p. 64 for a description of the key survey findings).

students with each intervention, but sometimes included implementation data as well.

OBSERVATIONS

We were participant-observers at project meetings, calls, and conferences over the course of the project. We took notes during each observation. Most data generated from observations was used to inform our background knowledge of each campus's projects and team members, as well as to serve as a form of triangulation against the documents and survey data.

INTERVIEWS AND FOCUS GROUPS

We conducted interviews with the teams (made up of faculty and staff) and administrative leaders at each campus, and led focus groups with participating faculty, students, and staff. Most of the formal interviews occurred at final site visits during the fall of implementation for the second cohort. The total number of interviews and focus group participants included 320 people with about 40 people (approximately 18 faculty, two administrators, 10 staff, and 10 students) at each campus.

Several protocols were developed to investigate and follow up on data from observations, reflective quarterly reports, evaluation studies, and survey data. Interviews were meant to explore and better understand these earlier forms of data and emerging findings. The interviews served as a form of trustworthiness and as a kind of member-checking that emerging themes were resonating with or reflected by campus participants. We developed a protocol for the team leaders and team members in charge of the intervention that focused on implementation challenges and facilitators, results of the evaluation (both formative and summative), the value of the three linked interventions, issues around collaboration, aspects of the campus environment such as policies and practices that may have impacted implementation, the value of working with other campuses and the system office, and lessons that they learned from implementing the three interventions.

The focus group protocol for participating staff and faculty (outside the team) asked first about their knowledge of the initiative and their involvement, their perceptions of the value of the three integrated interventions, and similar questions about implementation that were tailored to be more specific to how they were involved with the intervention. Questions for students in focus groups focused on their experience participating in the interventions, the value they perceived from the interventions, and ideas for improving the interventions. The faculty focus groups typically included all faculty involved in the intervention, i.e., the population not sample. However, for students, we chose a purposefully diverse sample based on gender, race, and major.

STEM
COLLABORATIVES

CHAPTER 3:

Value of CSU STEM Collaboratives

We examined the value of the STEM Collaboratives project for both students and the broader campus communities, over and above the retention and persistence data that the campuses monitored as a part of their evaluation plan (though we will bring in that data where relevant). In this section, we first discuss the value of the project for students and then discuss the value of the project for the broader campus community, including faculty, staff, and administrators.

3

Value for Students

As noted in previous sections of this report, one of our major questions had to do with the value of having interconnected interventions, over and above the value of just implementing individual HIPs. The CSU campuses that created the most integrated programs have seen corresponding improvements in student outcomes. Even though the project has only been operating a short time, data from the early cohorts suggest that there is a benefit for first-generation, low-income, URM students in STEM who participate in these types of integrated interventions. In this section, we first discuss the value for students using outcomes data from campus evaluations. We then elaborate on why the program was valuable for students and discuss the value in more depth.[7]

Even though the project has only been operating a short time, data from the early cohorts suggest that there is a benefit for first-generation, low-income, URM students in STEM who participate in these types of integrated interventions.

STUDENT OUTCOMES

Students who participated in STEM Collaboratives programs had positive outcomes

[7] As noted above, because the participating campuses designed distinctive programs based on their individual needs, each of the eight campuses conducted its own program evaluation. While all the campuses worked toward improved retention in STEM, many sites set additional goals such as improvements in students' sense of belonging or self-efficacy. A caveat when examining these outcomes: since campuses were responsible for designing their own evaluations, they structured their research designs and data analysis plans differently from one another. For example, some campuses had matched control groups, some campuses used random selection when selecting their participants, some had a non-comparable comparison group, some used multiple comparison groups, and some used historical control groups. Additionally, some campuses used more sophisticated analytic techniques, such as regression or propensity score matching, when analyzing their student performance data. Campuses also may have selected different measures for similar outcomes, such as sense of belonging or engagement. Because the grant funding ended in the middle of the academic year for the second cohort, some campuses only reported outcomes from Cohort 1.

compared to their non-participating peers. Below, we report on some highlights of the student outcomes data:

Retention/Persistence: Overall persistence rates were higher for STEM Collaboratives students at Fresno, Fullerton, Pomona, and Humboldt. These improvements ranged from modest (2-3 percentage points higher at Fresno) to substantial (12 percentage points higher at Humboldt). In addition to these campuses, Channel Islands, Dominguez Hills, East Bay, and CSULA all saw increased retention in STEM for participating students. For example, participants at Channel Islands were 7% more likely to be retained in STEM than non-participants and Dominguez Hills saw STEM retention rates that were 4 percentage points higher for participants. Fullerton, Fresno, East Bay, Humboldt, and CSULA saw double-digit percentage point increases in STEM retention for participants.

GPA and Course Pass Rates: Humboldt and CSULA both had higher overall GPAs for their participating students when compared to non-participants. Participants at East Bay and CSULA had higher STEM GPAs than non-participants. And pass rates in STEM courses were markedly higher for participants at Channel Islands, Dominguez Hills, and Humboldt.

Psychosocial Outcomes and Engagement: Participants at Humboldt experienced a greater sense of belonging on campus than non-participants because of their experiences in the program. Students at Pomona and East Bay noted higher levels of self-efficacy as a result of participating in the program. Engagement with campus activities or resources was higher for participating students at all campuses.

Other Notable Outcomes: At East Bay, biology content knowledge increased for participants over the course of the year. At Fresno, students attained proficiency in key critical-thinking and quantitative-reasoning skills. More participants at Fullerton earned 24 credits in their first year than non-participants. And at CSULA, participating students took more math and science courses in their first year than non-participants, putting them on track for an on-time graduation.

WHY IS IT VALUABLE FOR STUDENTS?

So, what is it exactly about these integrated programs that is beneficial for students? We found that the specific interventions themselves matter less than the integration of multiple support programs. Various types of interventions/HIPs could be effective for students. For example, at a primarily commuter campus such as Dominguez Hills, a full-time, traditional summer bridge program may not be the most effective intervention, as its students are more likely to have to work over the summer and may not be able to commit to the time required for a traditional summer bridge program. These students may benefit more from a shorter summer program or from more interventions in their classes. But having multiple, connected HIPs is beneficial, regardless of the type.

The value arises from *creating a holistic community of support* that can break the typically negative climate that many first-generation, low-income, and URM students face in STEM. In this section, we first describe the ways in which the STEM Collaboratives programs were able to improve that climate for first-year students. We then describe the value of cohorting, in that students had a community of peers going through similar experiences who could support one another. And third, we discuss the broader view of STEM education and careers that students developed because of their participation in the program.

We found that the specific interventions themselves matter less than the integration of multiple support programs.

First, the *unified community of support appeared to break down the negative STEM culture* that students, especially those historically underrepresented in STEM, experienced in their STEM courses. Participants in the STEM Collaboratives programs developed more realistic expectations for their STEM courses because of their participation in summer programs and through exposure to older peers who had already taken STEM courses. Students got to know their older near peers in STEM (sophomores, juniors, and seniors) through peer mentoring programs, peer-led team-learning (PLTL), or SI, as we describe in more detail in Chapter 4. These mentors helped them better understand the differences between high school and college courses, as well as expectations from faculty for study time and classroom engagement and behavior. Across nearly all the campuses, students also remarked on the value of getting to know their faculty members better. Outside-of-class experiences, such as summer programs or research trips, helped students get to know faculty as people rather than just as authority figures or gatekeepers to STEM knowledge and success. These relationships with faculty members also motivated students to be more engaged in their classes and made them more comfortable asking questions or admitting when something confused them. One student at CSULA remarked that "that's why I liked FYRE because [of] that more one-on-one relationship with your professors. So, it wasn't hard to go up to them and speak to them if you had any issues.... Because I think one time I asked for, my group, for something that we had to present, if we could get an extension, because we were behind. And it didn't feel that scary." Additionally, students had lower test anxiety and developed better study habits as a result of the connected interventions. All these experiences led to a more positive experience of STEM culture for students in the STEM Collaboratives programs.

Second, *cohorting itself seemed to promote separate, additional positive outcomes for students.* Cohorting students into the same shared experiences and courses developed a strong sense of belonging for students. Some campuses found data to support this increased sense of belonging. Humboldt and Fresno, for example, both measured sense of belonging in their students, and both campuses found an increase in this measure among students who participated in STEM Collaboratives. This strong cohort experience was evident at Humboldt, as numerous faculty and staff commented on the Klamath Connection students "traveling in herds" and always spending time together. One student at Dominguez Hills noted the benefit of taking summer courses and then fall courses with the same group of peers, that they "feel comfortable with them" and that there was "a lot of community within STEM majors." Cohorting students into the same courses and co-curricular activities also led students to support each other academically by creating study groups. At Humboldt, students made study groups for their cohorted classes and created a "studious community" by encouraging each other to study and sharing study materials. Students at CSULA also mentioned the value of studying with their peers rather than trying to prepare for tests and quizzes alone and noted they may have fallen behind if they tried to study alone. This cohort mentality continued even after the first year when formal STEM Collaboratives experiences had finished. Students on residential campuses decided to live together in their second year, and students across many of the campuses tried to take classes together of their own accord.

Finally, in addition to benefiting from this unified community of support, *students developed a broader view of education and of their future because of the holistic content and curricular connections* that were a part of the STEM Collaboratives program. Rather than a typical freshman-year experience in which course content is not thematically or intentionally connected, many STEM Collaboratives programs had a theme to connect courses and extra- and co-curricular experiences. Some of these themes, such as the Klamath River at Humboldt and the Port of Oakland at East Bay, are described in greater detail in other sections of this report. What is important to note is the value that themes had in connecting typically disparate experiences and creating a cohesive experience for students. Students reported that they were able to understand the connections between different courses or different disciplines because of the intentional integration of content. They also developed a better understanding of various majors and career options as a result of participating in the program. For example, students at Dominguez Hills remarked upon their stronger understanding of career options after being introduced to various careers during their summer experience. As a result of participating in summer research experiences and more hands-on experiments and projects in their courses, students also gained a stronger understanding of what it means to be a scientist. At CSULA, for example, students felt more confident in their abilities after building an underwater robot in their engineering course.

Value for Broader Campus Community

For all the value that the STEM Collaboratives program had for students, it may have had an even greater value for faculty, staff, and the broader campus communities at the participating CSU campuses. Creating an integrated program for STEM students led to numerous positive outcomes for the campus community.

BUILDING RELATIONSHIPS

In order to create a program with multiple integrated components, project team members had to build relationships with faculty and staff both within their own departments, across other departments, with departments outside of STEM, with student affairs and other administrative units, with student organizations, and, in some cases, with the broader community outside of the university. These relationships laid the foundation for collaboration across campus. At Dominguez Hills, for example, faculty spoke about their experiences building relationships with faculty in other STEM departments as they worked to plan their summer courses and to cohort their academic year courses. One science faculty member noted: "It's nice now to know someone in math. When my students come to me and say they are having a problem in math, I can bring them to someone who can answer the question." Some campuses, such as CSULA, made intentional efforts to build these connections through faculty learning communities, which bring faculty together for regular meetings around common topics or issues. Even campuses without FLCs, however, reported success building new relationships with other STEM faculty.

Teams on some campuses built relationships with non-STEM faculty, as well. At Channel Islands, math and English courses were linked for STEM Collaboratives students, and the faculty teaching these courses met regularly to discuss student progress and potential areas of collaboration. Fullerton also linked English/reading courses with their STEM courses, and several faculty from these disciplines joined the project team. At Humboldt, courses in English, communications, and Native American studies were all part of the learning community for students, and these faculty members became an integral part of the project team.

Relationships with faculty and staff both within their own departments, across other departments, with departments outside of STEM, with student affairs and other administrative units.

A key area of relationship-building occurred between faculty members and student affairs staff, as one of the goals of the STEM Collaboratives program was to encourage collaboration among these groups. While some campuses had more student affairs involvement than others, faculty across all campuses built new relationships or strengthened existing relationships with colleagues in student affairs. At Pomona, for example, faculty on the project team developed strong connections with the leaders of the summer program, so that they could build a STEM-specific experience into orientation. At Fresno, the Advising Resource Center was a key partner in the program and served as a facilitator connecting project faculty to other offices in the student affairs division that might provide relevant support, such as career services. Across all eight campuses, faculty developed new relationships with advising offices and the registrars because of their efforts to cohort students. These offices were integral partners in these efforts.

Teams at some campuses also tried to build relationships with existing student groups. Dominguez Hills, for example, attempted to collaborate with student organizations to host extracurricular activities. Faculty at several other campuses became more aware of STEM-related student organizations through this project. Peer mentors or SI leaders who were members of certain student organizations, such as Underrepresented Students in Science at Humboldt, also helped educate STEM Collaboratives students and faculty about these groups.

A few campuses also built relationships with community partners outside of the university. The East Bay team worked with staff at the Port of Oakland to develop a summer research experience for students in the first year of the program. Perhaps the most notable example of this community partnership-building arose at Humboldt, where faculty worked with scientists employed by local offices of state and federal governments, local tribal offices, and private companies to develop field experiences for their students.

LEARNING

All these relationships led to learning about the work of others on campus and in the community, generating a stronger sense of mutual respect and appreciation for each other's efforts. This learning gave team members a better understanding of how the campus works and enabled them to better navigate many of the logistical challenges they faced in implementing their programs. Team members learned about the work of other faculty members and student affairs staff, the experiences of their students, and the policies and practices needed to best support students.

Learning about Other Faculty Work

First, STEM Collaboratives faculty learned about courses taught by other faculty, specifically about what was being taught and how. For example, at Dominguez Hills, a computer science faculty member learned more about what was being taught in introductory math courses and found that some challenging mathematical concepts that were key for computer science students were not being taught. As a result, computer science faculty were able to incorporate these concepts into their courses rather than remain puzzled as to why students did not understand these concepts. Other campuses were also able to make pedagogical changes based on what they learned from these new relationships.

Learning about Student Affairs Work

Next, faculty at all campuses learned about the work that student affairs staff do, and developed greater appreciation for their unique contributions and knowledge (this is discussed more in Chapter 3). For example, faculty at Humboldt learned about the RAMP mentoring program, which helps first-generation and low-income students adjust to college through an intrusive advising model. Some faculty remarked that they did not really know what RAMP did until they became a part of the STEM Collaboratives project. Because of the relationships they built, however, faculty grew to understand and support the intrusive model of support that RAMP advocated—a traditional student affairs approach. Faculty we interviewed at Humboldt even brought up the developmental trajectory of first-year students and how that informed their approach to working with students—this is key student affairs knowledge that faculty did not have before their collaboration with student affairs. As a result of these improved relationships, faculty and student affairs staff developed a stronger sense of mutual respect for one another's work. At East Bay and Humboldt, for example, both groups mentioned that they now better understand the schedules, pressures, and demands that the other group faces in their role, and they have a stronger appreciation for their work as a result.

Learning about Students

STEM Collaboratives faculty also learned a lot more about students—the complexity of their lives and the challenges they face—as a result of the relationships they built across campus. One faculty member at Humboldt remarked that his expanded knowledge of students' needs was "like when the tide is out and you can see where the rocks are"—he had not previously been aware of issues like mental illness, homesickness or pressures from family, financial/food/housing insecurity, time management, stress, and partying intensity. He had been able to ignore these "rocks" because of "the water of my discipline washing over it," but his new way of interacting with students and colleagues made him aware of the complexity of students' lives in a way he had not been before. Faculty at other campuses also described similar learning about students' concerns and needs through the program. Non-STEM faculty and student affairs staff also developed a better understanding of STEM-specific challenges that students face, such as the rigor of their courseload or inadequate math preparation.

Learning about Needed Institutional Supports and Practices

Additionally, STEM Collaboratives teams learned about the types of institutional support and practices needed to better support students in STEM. Some of these practices were borrowed from other departments on campus or from other STEM Collaboratives campuses. DH borrowed PLTL from computer science to use in other departments. Other campuses also expanded peer mentoring or SI programs that already existed in some departments and spread them throughout STEM departments. Some campuses, such as East Bay, borrowed ideas from other STEM Collaboratives campuses. The East Bay team members were very impressed with SI at Fullerton and decided to add it to their program, even though it was not an original part of the design. As they designed and planned their programs, campus team members also learned about requirements for other majors outside their home discipline, which led them to better understand the connections between majors and the demands placed on departments such as math, which must meet the needs of all other STEM departments and general education. As a result, several campuses began working to create additional discipline-specific math courses to better meet the needs of certain majors. Campuses' own data also informed their learning about needed supports and practices. As teams reviewed data about student performance and the efficacy of their interventions, they learned what worked well and what could be improved.

Another practice that several of the STEM Collaboratives campuses learned was helpful for students was course redesign. This intervention was one of the three designated by the Chancellor's Office for inclusion in all STEM Collaboratives programs, but most faculty involved in the project found it to be a valuable experience and some campuses even expanded redesign beyond their initially designated courses. For example, Dominguez Hills redesigned its remedial chemistry sequence after finding success in its redesigned math courses. Additionally, CSULA found that its students struggled most with the non-redesigned physics course; it stood out as particularly difficult for students in comparison to their other redesigned courses. Math remediation was another practice that faculty across several campuses began rethinking because of this project. At Pomona, a co-requisite model of math remediation had some promising preliminary results, for example.

BETTER EXPERIENCES FOR FACULTY

The STEM Collaboratives program also facilitated better experiences for faculty in courses and with students. For example, at Fresno, faculty noted that it was now more rewarding to teach first-semester courses because students were more engaged from the beginning because of the community they built in their summer experiences and the confidence they gained from having a supportive group of peers, faculty, and staff. To that end, faculty who taught in the summer programs could build connections with students earlier than usual, allowing them to jump right into learning new material in the fall semester rather than spending weeks building rapport. Further, even at campuses where summer experiences were not taught by core tenured/tenure-track STEM disciplinary faculty, these faculty often taught introductory courses as a result of STEM Collaboratives. Students thus got early exposure to more senior professors in their field, which would not normally happen until much later in their college career. The relationships that faculty developed with students were stronger as a result of their additional exposure to students outside of the traditional fall and spring semesters and their earlier exposure to students in their freshman year.

Part-time faculty members and lecturers also noted that participating in the initiative allowed them to meet other faculty members, which was rare and something to be truly appreciated. The ability to brainstorm their courses and talk with other faculty helped them improve their teaching practice. These experiences all led to higher morale among faculty; they got to know students better, teaching became more enjoyable, and at campuses with theme-based programs faculty were also energized by the theme.

JOINT WORK AND NEW INITIATIVES

Through the relationships that participants in STEM Collaboratives built, faculty and staff have embarked upon new joint work that would not have happened before the program. First, teams across several campuses expressed more interest in undertaking professional development across STEM fields, as noted above. Some campuses, such as Channel Islands, Humboldt, CSULA, and Dominguez Hills, even incorporated a professional development component into new grants or funding requests. With their newly fortified relationships with student affairs and other offices on campus, some campuses (CSULA and Humboldt) are interested in incorporating topics such as stereotype threat or white privilege into their professional development, which campus participants say would never have happened before this project.

Additionally, teams across several campuses are embarking upon additional joint work with colleagues outside of the STEM Collaboratives team, such as active learning or course redesign efforts. For example, at Dominguez Hills faculty undertook a broader redesign in chemistry that reflected the work they had done redesigning courses for the STEM Collaboratives project. The project also led campus teams to rethink or re-examine broader campus policies related to student success, such as orientation at Humboldt. After seeing the success of the STEM Collaboratives summer immersion program, faculty and staff at Humboldt jointly decided to change the summer orientation from a traditional "firehose approach" with an overload of information about campus resources to a more targeted summer immersion with disciplinary linkages. Campuses also reexamined policies around such issues as registration (block registering), first-year seminar courses, and remediation (e.g., pre-requisite vs. co-requisite at Pomona).

Finally, teams are collaborating with partners across their campuses to submit new grants or undertake additional work in STEM. Nearly all campuses are building off their STEM Collaboratives work to submit for the HSI STEM grant, and some campuses are pursuing additional grants such as those from the Howard Hughes Medical Institute (HHMI). Humboldt is expanding the Klamath Connection and building an additional STEM learning community for chemistry and physics majors, and East Bay has expanded its Freshman Learning Communities to include STEM students with remedial needs.

UNIFIED COMMUNITY OF SUPPORT

Relationships, learning and mutual respect, better experiences for faculty, and joint work all facilitated the development of a unified community of support among faculty and staff on the CSU campuses. Students felt the value of this unified community of support, as described above, but in this section, we will describe in greater detail the way this unified community played out for faculty and staff. As one faculty member at Fresno noted, the STEM Collaboratives helped their team "form a community of people who are much more invested in keeping students in STEM and [who] know what to do" to retain students. Thanks to stronger relationships and greater communication, faculty and staff on STEM Collaboratives campuses were able to identify student needs and ways to support those needs. Faculty in different disciplines were able to align their classes so that students experienced a more seamless and connected curriculum. Non-STEM faculty became more knowledgeable about STEM student challenges, and STEM faculty became more aware of general challenges that students face in their non-STEM classes and outside of class. Better relationships with student affairs facilitated this knowledge; at the same time, student affairs staff also learned about STEM-specific issues and could better advise and support STEM students. Additionally, the most successful campuses built larger-scale programs impacting hundreds of students, and more URM and varied types of students were supported because of these comprehensive programs. Faculty across disciplines and staff across departments all developed a shared understanding of students' needs, experiences, and requirements for the first year of college. Part of this shared knowledge was about how different parts of the university work; as faculty and staff developed a stronger sense of how different pieces of the institution work, they were able to better understand how students experience disparate pieces and support them. For example, at CSULA, one faculty member spoke about her ability to now call financial aid if a student had a hold on his or her account and work together to figure out a way around the problem, whereas before she might not have even been aware that there was an issue. These shared understandings and abilities to work together to solve problems created the sense of a unified community supporting STEM students as they transitioned to college.

NEW MODELS OF WORK

These unified communities of support created models for new ways of doing work on the STEM Collaboratives campuses. First, cohorting students and aligning programs in general represent new ways of working in higher education, as opposed to the prevalent "cafeteria college" model identified by Bailey, Jagger, and Jenkins (2015) in which courses, majors, and support programs are all disparate and unconnected. By integrating content across courses, connecting faculty and staff so that students are better supported both inside and outside the classroom, and cohorting students together so they develop community through shared experiences, the STEM Collaboratives program presents an alternative to this traditional cafeteria model, in which the burden of responsibility is on students to pick and choose the items that they think will best compose a successful and balanced educational experience. As other campus stakeholders have seen the success of this alternative model, this way of working has spread beyond just the original STEM Collaboratives projects. At Humboldt, for example, two new, theme-based learning communities are being developed because of the success of the original Klamath Connection program. One is an additional STEM-based community, but the other is for undecided students and incorporates humanities and social sciences as well as STEM. At Dominguez Hills, English faculty are interested in adopting the model that FUSE used for its at-risk math students. And CSULA has developed a sophomore year initiative to continue the support it built for freshman students. None of these initiatives would have been possible without the STEM Collaboratives groups paving the way and showing that new ways of collaborating and integrating programs are possible.

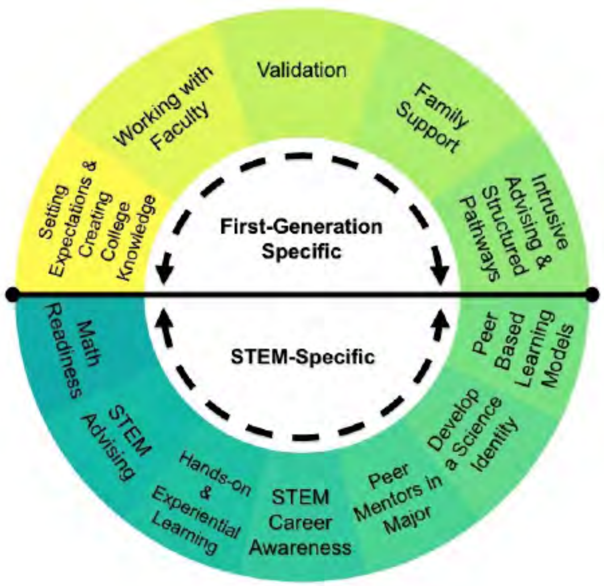
Conclusion

Overall, this project led to an increased capacity at STEM Collaboratives campuses for the type of complex problem-solving necessary to address the complicated challenges of STEM student success. As groups of faculty and staff from multiple departments built relationships and developed mutual respect for each other's work, they learned many lessons about how best to support low-income, first-generation, URM students in STEM; these lessons were also transferable, in some cases, to students in other fields. Ultimately, the most successful campuses developed a unified community of support, in which faculty and staff all worked toward the same goal of supporting STEM student success both inside and outside the classroom. This unified community was felt and experienced by students, who developed strong relationships with each other, older peers, faculty, and staff and built the sense of belonging and confidence necessary to succeed in their first year as STEM majors. At the most successful campuses, this value was demonstrated through student persistence or achievement data. Even campuses that struggled more with implementation still showed some positive outcomes for students. Regardless of their student outcome data, there was value across all campuses as faculty and staff collaborated, learned, and developed new ways of working together to support student success. The clear value of this project also contributes to sustainability, as campus stakeholders can see the value at various stages of the process.

STEM COLLABORATIVES

CHAPTER 4:

Elements of STEM Student Success



"Becoming a community oriented to student success in itself is the most important end result"—faculty member

Having described the broad-ranging value of the initiative for faculty, staff, and students, in this chapter we focus on one of the most important value propositions added by the initiative—the creation of a unified community of support for STEM student success.

Further, the initiative and study helped to identify the elements needed to create such a community of support. One of the most important insights from our study of the CSU STEM Collaboratives is that the elements of first-generation, STEM student success are locked into separate silos—academic affairs and student affairs—that almost never connect, leading to the creation of interventions that almost always meet only half the demands that first-generation, low-income, and underrepresented minority students in STEM face.

Faculty in STEM and leaders in academic affairs possess important knowledge related to assisting in STEM students' transition to college and their sustained success. They can help advise students on the right course sequences to take, help them to address deficits in math, connect them to important experiences that help them succeed in STEM such as undergraduate research, internships, and field experiences. In kind, we found that student affairs staff largely did not understand the unique needs and challenges that STEM students face.

However, student affairs offices understand how first-generation college students may struggle to understand the expectations of college and how to navigate their first year academically, whether it be speaking to a faculty member or attending office hours. These students may also have extra challenges when it comes to family responsibilities and work; they may come from underresourced and inadequate high school environments, and often have experienced traumas. Student affairs staff recognize that students need validation and support in the face of these many additional hurdles. Staff members also recognize that these students are looking for validation of their cultural backgrounds; too often, students face a deficit perspective from the individuals they interact with on campus rather than a recognition of the assets they bring. In this section, we document how this knowledge in student affairs is rarely understood by STEM faculty and leaders in academic affairs. Thus, the knowledge that faculty and academic affairs leaders have to help STEM students succeed is also siloed.

Interventions developed for first-generation STEM students often emphasize just one of these areas depending on the office or division that is responsible for creating the program or initiative. What our study identified is the importance of academic and student affairs working together to develop interventions that use the knowledge that exists amongst both divisions and can help lead to STEM student success. In fact, the CSU STEM Collaboratives required teams to involve both academic and student affairs. Yet, as we will describe throughout this report, the CSU system/campuses have deep divisions between academic and student affairs that make the sharing of knowledge across these siloed divisions extremely difficult. Even though the initiative required working across academic and student affairs units, many of the campuses struggled to work in ways that broke down these divisions. However, the evaluation data demonstrated that campuses that truly utilized knowledge from both academic and student affairs had much stronger student outcome data. Working across these divisional silos resulted in greater retention, important psychosocial outcomes such as sense of belonging and academic self-efficacy, student learning, and, we believe, ultimately graduation. While the students still have two years to graduation, all the early signs suggest that working across academic and student affairs is one of the most critical components to student success and graduation.

In the previous chapter and throughout this report, we highlight that students' success—including STEM student success—requires developing a unified community of support for students. A unified community of support brings together the knowledge of academic and student affairs in order to develop the appropriate interventions for students, to develop multiple touch points of support, and relationships and a community that is there for students as they encounter challenges. What single interventions (or even multiple disconnected interventions) typically fail to create is the kind of ongoing community, relationships, and touch points that are needed.

However, the evaluation data demonstrated that campuses that truly utilized knowledge from both academic and student affairs had much stronger student outcome data.

While the STEM Collaboratives included the utilization of three key interventions—summer experiences, first-year experiences, and redesigned introductory STEM courses—we found limited evidence that these three interventions in themselves are necessary for STEM students' success. In fact, on some of the campuses, we found that the summer experience may not be needed, that first-year experiences/seminars may repeat information for some students who take summer bridge, or that students have difficulties aligning their work schedules with an intensive summer bridge. The type of interventions needed varied and should be developed by academic and student affairs working together to craft the best solutions that meet the needs of the campuses' specific students. Instead, what we found is that aligning these three programs required academic and student affairs staff to work together, to learn from each other, and to develop interventions that included knowledge from both communities. It is this unified community of support, informed by core knowledge from academic and student affairs, that was ultimately the most important aspect for STEM student success.

In bringing together the expertise of academic and student affairs, the campuses that were part of the CSU STEM Collaboratives made important changes that went above and beyond aligning the three interventions and cohorting students. They improved the advising of first-year students, created new approaches to math readiness, altered orientation and incoming programs, and became a template for new ways of working together. At some campuses that were part of this initiative, there was a bias to orient the intervention toward academic affairs if there were more faculty members on the team or student affairs if their staffers were a larger presence or significant voice on the team. Therefore, we underscore the importance of balancing both STEM-specific issues known by the faculty and first-generation issues known by the student affairs staff. And we do not mean to fully dichotomize this knowledge, as we found occasional faculty members who had knowledge of issues for first-generation college students—in fact some of these faculty had been first-generation students themselves. But overall, these deep divisions and separate spheres of specialized knowledge exist across the CSU campuses.

STEM-Specific Issues

In our interviews with faculty and staff in academic affairs we found that they were very knowledgeable about STEM-specific challenges. We highlight a sampling of some of the key knowledge that is important to STEM student success in the first year. These are not meant to be a comprehensive list of all STEM-specific issues, but rather just the most salient ones that were most often articulated at CSU campuses. These areas are also noted in the literature about STEM student transition and success.

MATH READINESS

Faculty and academic affairs staff know that without the proper command of math, students will not be successful in STEM. They also recognize that many students come into the CSU needing math remediation. Math needs to be central to any intervention to support STEM student success. CSU STEM Collaboratives projects involved a range of approaches. For example, Pomona had students take co-requisite remedial courses so they could begin their credit-bearing math sequences earlier and not get behind in their studies. Several campuses, such as Dominguez Hills, had intensive training in math built into their summer experiences. And several campuses were exploring and adopting models from other CSU campuses such as San Bernardino and Northridge.

STEM ADVISING

We heard repeated stories about STEM students taking the wrong sequence of courses when they have been advised incorrectly by the general campus advising staff. Faculty noted the importance of students getting direct advising from STEM-specific advisors or STEM faculty. Faculty or specialized advisors have more familiarity with majors, sequences of courses, and also know the importance of taking math early. Too often we heard stories of students being advised to wait to take their math or science requirements because it would be too overwhelming and difficult in their first year. However, this is not an option for STEM students, for whom math is foundational to their other coursework. Students who were misadvised in this way got so far behind that they typically had to change majors out of STEM. As part of the CSU STEM Collaboratives, many campuses worked to involve faculty more in advising. For example, at Dominguez Hills an intrusive advising process with first-year STEM students was established. Students that we talked to at STEM Collaboratives campuses appreciated the requirement to see faculty advisors. One student at CSULA noted the importance of accurate advising for progress toward his degree: “the FYRE program, not only do they help you with your classes, they keep you on track. They basically guided me towards the classes I need to take. And they guided me through those classes. And if it weren’t for the FYRE program, I think I would be behind on units. I’d be a little confused.”

HANDS-ON AND EXPERIENTIAL LEARNING

Faculty recognize the importance of hands-on and experiential learning for STEM students, especially to create motivation in the face of very challenging courses. CSU STEM Collaboratives campuses utilized a variety of hands-on experiences that students rated very highly for improving their success. For example, at CSULA, students simulated an earthquake. At Humboldt, they took a multi-day field trip out to the Klamath River to do fieldwork. Faculty recognize that these real-world experiences are pivotal for keeping students in STEM.

STEM CAREER AWARENESS

Another motivating factor that faculty recognize is communicating the variety of careers that students might undertake with their STEM degrees. Faculty talked about bringing in speakers from industry, connecting with career centers, and helping place students in internships. Students usually have a narrow understanding of the careers available and are commonly interested in medical fields, which are often the only ones they know about. For first-generation college students, understanding the career options available within a particular STEM major is important for their persistence and success. Many of the STEM Collaboratives projects involved educating students about careers. For example, at Channel Islands students took a career assessment and had workshops in their first semester. At Fullerton, the first-year seminar included an introduction to many different STEM careers through outside speakers.

PEER MENTORS IN MAJOR

While student affairs staff often emphasized the importance of peer mentoring, faculty noted that having peer mentors who were STEM majors was especially beneficial for student success. Peer mentors from the same majors as first-year students were even better. And if mentors could be students of color or first-generation students in STEM, that was the most ideal. The faculty recognize that a key to success for underrepresented students in STEM is seeing that people like them can succeed.

PEER-BASED LEARNING MODELS

Building on the power of peers to increase STEM student success, faculty recognized that peer-based learning models such as supplemental instruction (SI) are critical to student success. In fact, supplemental instruction is one of the most well-documented models of successful student support in the CSU system. Faculty recognize that students often feel less intimidated asking questions of peers. In observing SI at CSULA, we witnessed firsthand the power of SI. Students were applauding other students as they solved difficult problems, there was noticeable camaraderie within the groups, and the SI leaders were clearly well-trained, as they provided no answers to students but asked all the right questions to get them to solve their own problems.

DEVELOPING A SCIENCE IDENTITY

Faculty recognize it is important for STEM students to identify as scientists and that this identification helps their persistence in STEM. In many ways, a science identity was created through the series of other important interventions that faculty typically deployed, such as hands-on and experiential learning where students tried out being a scientist, group work and cohorting students so they interact with others becoming scientists, as well as SI, undergraduate research and internships where they see science being modeled, and various other interventions that faculty recognize are important for STEM student success.

First-Generation-Specific Issues

Student affairs staff have a strong understanding of the needs of first-generation, low-income, and underrepresented minority students. Campuses that had more faculty-led initiatives typically had limited or no understanding of these challenges, and their interventions were missing key supports to help these students succeed in their first year in STEM. The four campuses in our study that most effectively bridged academic and student affairs knowledge had faculty who commented: “We learned to see students as people; students want to be heard; cared about.” In this section, we document what student affairs staff in the CSU system describe as important to first-generation students’ success, but research also supports all of these areas below as critical to transition and success. Like the above section, here we offer just a few of the key sets of knowledge that student affairs staff possess and not a comprehensive list.

SETTING EXPECTATIONS AND CREATING COLLEGE KNOWLEDGE

Student affairs staff are well aware that first-generation college students lack basic knowledge about college; for example, that college-level work will be less structured, more challenging, and requires students to seek help when they are having difficulties. Student affairs staff also recognize that first-generation students likely need support in developing this college knowledge, which includes an understanding of how to talk to faculty, the various resources available on campus, what majors are, how to read a syllabus, study, utilize office hours, and other information that non-first-generation students may have learned from their parents. The STEM Collaboratives focus on summer experiences and FYE was aimed to address the issue of college knowledge and expectations. On campuses unable to bridge the divide between academic and student affairs, the work of creating college knowledge was often narrowly contained within the summer bridge program and not repeated within redesigned introductory STEM courses or first-year experiences, as faculty typically were not introduced to the importance of recalibrating students’ expectations. However, campuses that bridged the divide provided multiple touch points for students throughout their first year, where they developed college knowledge through a unified community of support.

INTRUSIVE ADVISING AND STRUCTURED PATHWAYS

Given their lack of college knowledge, first-generation college students are better supported when they have intrusive advising that looks at their performance halfway through courses, requires them to sit down with advisors to create their schedules and discuss their major, and provides feedback when they are not performing adequately in courses. College campuses are typically set up in very autonomous ways that first-generation college students find confusing. Having intrusive advising allows them to get some structure and support so they do not fall through the cracks. However, faculty who lacked this understanding felt uncomfortable intruding, believing students were adults and such intervention was inappropriate. In addition to more intrusive advising, creating more structured pathways by having series of required courses rather than a menu of options is another way to help reduce the confusion for students.

VALIDATION

Because first-generation college students come from families that have not gone to college and often come from communities where few people have gone to college, they often question whether they belong in college. Because they are questioning whether they are college material, it is extremely important for them to receive validation from staff, students, and faculty. Peer mentoring is one way to create validation from other students with similar backgrounds. Staff working in programs focused on first-generation college students often provide validation in terms of encouraging comments and trying to identify assets that the students have that they can emphasize to help build their confidence. Faculty sometimes lack knowledge of the importance of validation and in fact can create invalidating experiences that can lead students to drop out.

WORKING WITH FACULTY

First-generation college students typically lack an understanding about how to approach faculty members because the relationship is so different from the relationships they had with teachers in high school. Student affairs staff tend to have the knowledge of this gap for first-generation college students and provide advice about how to email a faculty member, ways to approach them after class, and how to ask questions. Student affairs staff also encourage students to have conversations with faculty members and hold them accountable for having such conversations, by having follow-up appointments with the students asking them about their meeting with the faculty member. For example, at CSULA, one assignment in the summer bridge program is to write an email to a faculty member and get feedback from faculty and staff.

FAMILY SUPPORT

First-generation, low-income, and underrepresented minority students typically have strong ties to their families, making family support critical to their transition and persistence. As a result, student affairs staff develop programs that include family members and they also talk about family concerns and issues with students. For example, at CSULA, the summer bridge program brings in family members to help them understand college and the support that students are going to need. Faculty who worked on the summer bridge program were introduced to the importance of family for the first time. Bridging the divide resulted in faculty members who now bring up family and personal concerns with students, which they had not done before.

Conclusion

Ultimately, what our study identified is that first-generation, low-income, and URM STEM student success is contingent on addressing both first-generation-specific issues and STEM-specific issues. The issues we outlined have also been well-documented in research studies (Tsui, 2007). In this study, we identified that these “knowledges” related to student success are trapped in organizational silos that rarely come together to create a holistic intervention that would lead to greater student success.

We also identified how the composition or orientation of the project team could affect the knowledges that are brought to bear on supporting STEM student success. For example, on campuses that had a stronger orientation toward student affairs interventions, they often ignored significant problems of math, did not set up mentors with the same majors, did not provide students with hands-on opportunities to motivate them through their courses, did not have the tutoring center working with faculty in the majors, did not link students to undergraduate research and internships, or describe careers in STEM. And students noticed these gaps and in evaluation data specifically asked for opportunities for experiential learning, workshops on careers, and mentors who understood their specific majors. And similarly, interventions that were heavily led by faculty ignored the important first-generation college student issues of validation, college knowledge, or clear expectations and guided pathways.

To create a unified and holistic approach that would help STEM students succeed, we need academic and student affairs to work together; we need to break down the organizational silos. We found no support for the idea that STEM student success is reliant on any particular individual intervention or high-impact practice. Summer bridge, FYE, or redesigned courses are not silver bullet solutions. Instead, any kind of program that integrates and addresses the aforementioned STEM and first-generation needs can achieve success. It is less about specific types of interventions than it is about meeting the specific student needs.

STEM
COLLABORATIVES

CHAPTER 5:

Campus Models of Success

In this chapter, we provide two examples of very different campuses with distinctive types of students and the ways that they created a unified community of support by aligning three programmatic efforts. In Chapter 2, we reviewed all of the CSU STEM Collaboratives projects. Here we provide more detail about two campuses that had very different models but achieved the same goal—creating a big, unified community of support for first-generation, low-income, URM STEM students. These examples also preview the next three sections on the value of the aligned programs, the implementation issues, and ideas about fostering collaboration.

Model of Differentiated Support for High-Needs Students at a Commuter Campus

Dominguez Hills has among the largest numbers of first-generation, low-income, and underrepresented minority students of any of the CSUs. One of the first design issues that Dominguez Hills faced was that students who expressed an interest in STEM came in at very different levels of preparation. As such, its summer bridge program had three different tracks to accommodate these varying levels of preparation. Some students went for just two 3-hour sessions, some students went 2 hours twice a week for four or six weeks, and some went to the Early Start Summer Bridge for 3.5 hours, four days a week for six weeks. While complex to manage, it allowed for the development of a program that could serve all students who had an interest in STEM. It also helped to ensure that students were college ready, particularly in math. One of the major problems Dominguez Hills identified is that the advising office on campus had been telling students to wait to take their math until after their first year, even for students who did not need remediation. This significantly increased the time to graduation for students in STEM, as they are not able to take other STEM courses until they meet their math requirements. Other campuses chose to only serve students who did not have remedial education needs, which made their program designs much less complex and easier to implement. But the team members at Dominguez Hills wanted to make sure that their program prepared all STEM students who expressed an interest. Over the summer, the work to develop a sense of identity for students was achieved and then fulfilled through their cohorted classes in the first year. They motivated students to sign up for the summer bridge by providing preferential enrollment for fall and spring for first-year courses.

The three different tracks for the summer bridge program continued into the first semester. In students' first semester they took a common math course (precalculus or Calculus I) plus chemistry or computer science courses "as needed," including peer-led team-learning sessions. The faculty members worked together to redesign the courses to include active learning and relevant examples from real life to make the material more engaging. The team also partnered with student clubs to host social events.

The Dominguez Hills program changed between Year 1 and Year 2. Many of the changes are the result of implementation barriers encountered in the first year. By the end of the first year, Dominguez Hills team members realized that they had made many faulty assumptions about support programs and units around campus and how they operated. The team members took the opportunity to sit down and meet with different offices and really get to know their work so they could better work together in support of the FUSE program. They capitalized more on the existing summer bridge in Year 2 and better integrated first-year processes like admissions, learning center, advising, registration, welcome week, and first-year experience courses. Project leaders also made sure to invite deans and central administrators to key team meetings of FUSE to help them strengthen relationships with other offices across campus and overcome implementation barriers. They worked on the overall design of the program, which had not considered students' varying entry capacities for math as well as the commuter status of most students. The implementation barriers in Year 1 were overcome through intentional collaboration in Year 2.

While the summer was challenging to implement, in its evaluations the team found that students believed the summer experience was valuable. Most importantly, the evaluation data has shown that students are now math-ready and able to enroll in science courses in their first semester. Additionally, students in the redesigned precalculus course are passing the course at nearly double the rates of students in non-redesigned sections. The team's partnership with advising has really paid off in students taking the appropriate sequence of courses, as they had identified students taking the wrong courses as one of the major barriers to majoring and persisting as a STEM student. Evaluation data also showed supplemental instruction (SI) and peer-led team-learning (PLTL) positively impacted student learning and outcomes, as students who enrolled in courses with these supports did better than students in a control group who did not have SI or PTLT. These positive outcomes have resulted in sustained funding for this aspect of the program—an area that had added more substantial costs. In Year 2, FUSE scaled to 100 students who did the six-week summer course and continued into the redesigned courses. The evaluation data for the second cohort show that students feel a sense of belonging, note they are developing an identity with FUSE, and feel like they are receiving integrated support. Students noted that the many hands-on learning assignments really motivated their interest in continuing to major in STEM as well as to seek out opportunities for internships and undergraduate research. They believe they are really understanding what the work of science looks like.

The value of this initiative for this campus has been substantial. Both faculty and staff express that they have a much better understanding of students' needs and are now more capable of ensuring their success. STEM departments are now working together on grants, professional development, and course redesign—they are learning from each other. And the STEM faculty have learned about other units on campus, such as the learning center, and ways they support students; faculty are now much more adept at referring students to these resources. Student affairs professionals note that they have a much better understanding of the specific challenges of STEM students. There is now greater communication between faculty and student affairs, as they have built personal relationships that will outlast the initiative. All in all, the team is excited that the program (all three interventions) will be sustained after the CSU STEM Collaboratives funding goes away. Dominguez Hills' summer bridge program is now a regular part of STEM students' transition. There is a new approach to math that is leading to success, and a set of redesigned introductory science courses (with active learning and a hands-on approach to science) with plans to continue to expand them. Additionally, the cohorted classes, new advising structure, and variety of supports in the first year including supplemental instruction, PLTL, and workshops, will continue to support STEM students' success at Dominguez Hills.

Not all of the challenges are worked out; for example, the team still needs to figure out better ways to integrate part-time faculty who do a lot of the teaching in math and first-year introductory courses. Also, only some faculty are involved in course redesign and chairs have had difficulty providing motivation to get more faculty involved. The team would also like to develop more coordination with student organizations and clubs. While the team members continue to work on these challenges, their evaluation results provide them motivation to continue and address these remaining issues. They are confident that the spirit of collaboration that moved them this far will help to address these remaining issues.

Model of Transformative Place-Based Learning Community

In some ways, Humboldt has a more "traditional" model of college education than Dominguez Hills. It is primarily a residential campus and it has fewer low-income, first-generation, URM students who are working part-time or full-time to support themselves or their families while they are in college. However, Humboldt has admitted an increasing number of Latino/Hispanic and low-income students over the last decade or so. Humboldt also has a much stronger STEM focus than Dominguez Hills, with many environmentally-focused programs and specific science majors such as Wildlife Studies and Fisheries Biology that are not found in other CSUs. Graduation rates at Humboldt lag behind the CSU system average (42% overall and 43% in STEM), and gaps are greater for URM students at Humboldt (28% for URM overall and 20% for URM in STEM). These unique circumstances led the Humboldt STEM Collaboratives team to create a program that took advantage of their campus's idiosyncrasies and built a supportive learning community around a place-based theme. Called the Klamath Connection (KC), for the nearby Klamath River Basin, Humboldt's program integrated a summer immersion experience with fieldwork at the Klamath River, a new 1-credit, first-year seminar (FYS) course, and linked redesigned courses in both STEM and non-STEM disciplines, all of which incorporated the Klamath River theme in some capacity. The goal was to foster a sense of belonging for incoming underrepresented STEM students by building relationships with peers, faculty, staff, the larger community around Humboldt, and the natural world through the Klamath River.

Unlike Dominguez Hills, Humboldt chose to serve only students without remedial math needs in its first year of implementation, making the academic elements of its program somewhat less complex to implement than those at Dominguez Hills (Humboldt did expand to serve students with remedial needs in the second year, however). Students majoring in Wildlife Studies, Environmental Science, Zoology, and Biology were eligible for participation in the program the first year, and 63 students participated in the initial cohort.

Humboldt tested two different four-day summer immersion experiences in the first year, one that involved camping near the Klamath River and another that involved day-long field trips to the Klamath River without overnight camping. These summer immersion experiences took place just before the general campus orientation program. Once the school year began, Klamath Connection students were block-enrolled in courses together based on their majors. These courses included science and math classes, as well as non-STEM general education courses in communication, critical thinking, and Native American Studies. These courses were all modified to include components related to the Klamath Connection theme. For example, students collected water samples in the summer immersion program that were then used in a new chemistry lab. The Native American Studies course introduced students to sociocultural and environmental issues related to local tribes residing near the Klamath River Basin. Several of these sections incorporated Supplemental Instruction (SI), which many students indicated was helpful for their learning. Additionally, students were enrolled in a 1-credit FYS course; these new courses were linked to majors and included both STEM content and other college knowledge information and skill-building.

There was a focus on interdisciplinarity and building connections across multiple fields around this common place-based theme.

Students were also assigned a mentor through the RAMP program, an existing mentoring program on campus for first-generation college students. RAMP mentors participated in the summer immersion program with freshmen students, as well as the FYS. They helped students navigate the transition to college. This linkage with an existing program benefited both RAMP and Klamath Connection, as the program could demonstrate the value of mentoring through its strong assessment plan and RAMP had a ready-made pool of potential mentors, an existing training program, and a host of student affairs knowledge it could share with faculty teaching in the learning community.

The Humboldt team members were able to correctly identify a problem and solution early on and did not let their focus waver from implementing the program as designed. They also designed a strong evaluation plan to test the impact of the program. Because of this tight alignment between problem, solution, implementation, and evaluation, the Humboldt team was able to make changes after the first year of implementation and demonstrate the impact of its project. Persistence was 12 percentage points higher for KC students compared to a reference group of similar students, and retention in STEM was 14 percentage points higher. Additionally, the summer immersion experience built a strong sense of belonging and community for KC students, and that sense of belonging grew for participating students compared to non-KC students. While students really enjoyed the summer immersion camping experience, it was very expensive and outcomes were not significantly better than for non-camping students; as a result, the Humboldt team decided to eliminate the camping experience for students in the second year. The program also added two additional majors the second year, Fisheries and Engineering, and the second cohort grew to 118 students. Additional courses were redesigned for the second year as well, including a Fisheries course and an introductory English course.

The Klamath Connection program was extremely beneficial for the Humboldt campus community, as well. There was tremendous buy-in among faculty and staff around the place-based theme; it generated a lot of excitement and encouraged faculty to participate. Team members called this excitement “contagious” and noted a “Pied Piper effect” in the momentum that built around the program. At our campus visit nearly two years after implementation began, team members described how faculty and staff around campus were now eagerly volunteering to participate in the program because of the engaging theme, evidence of success for students, and the community of faculty and staff that developed through the project. This community was cultivated intentionally by project leaders; they hosted regular happy hours and had regular meetings with participants for both planning and relationship-building purposes. Team leaders were also intentional and strategic about who they initially asked to join the team and how they won over key campus leaders. For example, the team sent a group to the learning communities conference at Evergreen State College to build buy-in and knowledge among key stakeholders from both faculty and student affairs. They selected this group carefully including some who were initially skeptical of the project. These conference attendees eventually became some of the project’s biggest champions, even the initial skeptics. The team also paid a lot of attention to internal communication for multiple audiences. In addition to sending a regular emailed newsletter updating students and faculty about program activities and events, team leaders met in person with prospective faculty and staff partners to hear their ideas and inform them about the program; they also met regularly with campus leaders to get buy-in and support from the top levels of administration. As a result, the Klamath Connection project became very visible and gained campus-wide support. Nearly everyone on campus knew about the Klamath Connection, from administrators

to faculty; even candidates for faculty positions in STEM fields learned about the program when they came to campus for interviews.

Humboldt had one of the most authentically collaborative project teams, with participants from faculty, student affairs, and other staff at all levels of seniority influencing different areas of the project. For example, they built key partnerships with residential life, library services, orientation, and RAMP, as well as multiple STEM and non-STEM departments. They have broken down some of the barriers between student affairs and academic affairs that are so common in higher education and in the CSU specifically.

Humboldt also did not have some of the implementation challenges that other campuses faced. Humboldt had more broad-based buy-in, as mentioned above, but the team also chose not to create a lot of new programmatic elements, as did some other campuses that created entirely new programs. The KC team partnered with RAMP for its summer immersion, and created a new FYS but adapted an existing course that was already on the books. Courses were redesigned to varying degrees, with some incorporating just a few new assignments related to the Klamath River theme and others more comprehensively overhauled in terms of both content and pedagogy. Humboldt also had two dedicated staff members, a STEM VISTA and a project coordinator, who helped significantly with many of the logistical challenges that stymied other campuses.

Finally, Klamath Connection inspired other groups of faculty and staff across campus to undertake similar collaborative work and make broader changes to support student success. An additional theme-based STEM learning community for physics, geology, and chemistry is launching in the 2017-2018 school year, and a non-STEM-specific learning community for undecided students is in development. Stakeholders across campus have bought into the theme-based, interdisciplinary learning community model as one that has proven positive results for students and demonstrated benefits for faculty and staff.

Approaches to Program Alignment/Integrating Mechanisms

One of the most valuable lessons learned from the campuses was key mechanisms that can help facilitate alignment of the programs. Campuses had the most success at implementing a thematic approach across the three interventions, but other structures exist that can be used to create integration across different experiences for students.

THEMATIC APPROACH

Perhaps the most widely used approach to connect the summer experience, FYE, and redesigned courses was to develop a theme that served as a point of connection across all three of the interventions. As noted in this section, Humboldt used the Klamath River as a theme that united the faculty and staff on campus and even their outside community. Fresno and Channel Islands used sustainability as their theme. East Bay used the nearby Port of Oakland. The theme became a centering or focal point across the different interventions for crafting assignments, projects, and conversation. Picking a theme that motivated both staff and faculty was important for getting buy-in from different stakeholder groups and promoting the energy and enthusiasm necessary to do the extra work involved with implementing the project.

PROFESSIONAL LEARNING COMMUNITY

Several campuses utilized a professional learning community (PLC) model, where they had regular meetings of faculty and staff participating in the three interventions and invited other faculty and staff who work with first-generation, low-income, and underrepresented minority students in STEM. CSULA and Fresno developed formal professional learning communities, while other campuses had ongoing working groups that approximated a learning community, such as Dominguez Hills and Humboldt. Through the PLC, faculty and staff working on the different interventions had the opportunity to regularly communicate and hear about each other's work, as well as learn together about topics related to student success. However, some of the PLCs described challenges in not being able to pick topics of sufficient interest to maintain regular attendance and engagement at meetings. For example, if the general topic is first-generation student success, sometimes the attendance of faculty members declined. Therefore, PLCs need to be carefully crafted around a set of jointly appealing issues that the group itself chooses so as to ensure that they continue to attend and benefit from the community.

PATHWAYS OR STRUCTURED CURRICULUM

Fullerton recently introduced General Education (GE) pathways, which connected GE courses around a certain discipline or topic. Its STEM Collaboratives project capitalized on these existing cohorted courses and created a new STEM-specific GE Pathway. Some of the other campuses had also already created cohorted experiences, such as structured pathways or first-year interest groups. Such initiatives generally require support from the overall campus in terms of working through registration, admissions, and advising to connect programs and create a coherent experience for students. Therefore, utilizing these infrastructures can be a way to piggyback on other efforts and achieve the goals of an aligned program.

STEM CENTER

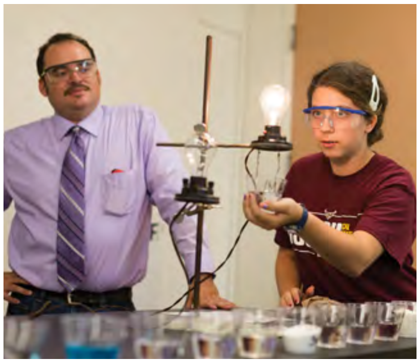
East Bay had a STEM Education Center that could serve as a hub to connect different educational experiences. Other campuses are also developing some form of center to support STEM education; if nothing else to centralize their various externally funded grants (e.g., National Science Foundation, National Institutes of Health) and to align these grant-supported efforts. One challenge to these centers is that they sit outside the traditional structure and typically have the same challenges of not being connected to student affairs or the administration in ways needed to support an aligned program and create a broader unified community of support. In addition, many of these programs require that grant funds go to participants and do not support student affairs involvement or other campus administrative support. However, we see that there may be potential in increasing their value and impact if they understand the need to collaborate with others on campus to meet their goals.

ADVISING AND/OR TECHNOLOGY SYSTEMS

CSULA explored an advising tool that would connect across students' experiences, called the Golden Eagle Flight Plan. The use of technology to follow students across their various experiences on campus and to help staff and faculty align support to students' overall choices is an important future direction. While none of the campuses utilized electronic portfolios, we see this as another potential opportunity for integrating programs through online tools. We recommend that campuses explore technology systems and more comprehensive advising approaches that might help to create aligned programmatic interventions.

STEM COLLABORATIVES

CHAPTER 6:



Collaboration Challenges and Supports

"This initiative has given a punch to the stomach to the divide among faculty and staff in the CSU system"—staff member

As we have noted repeatedly throughout this report, collaboration between academic affairs and student affairs was a key determinant of success in the STEM Collaboratives programs. In this chapter, we briefly discuss some of the research on collaboration and review a model that explains some of the elements that are critical for facilitating collaboration. We then describe how these elements were evident at both Dominguez Hills and Humboldt, two of the most successful campuses. We conclude this chapter with a brief look at some of the challenges to collaboration not covered in previous chapters.

Collaboration Research and Introduction to Model

When we think about collaboration in the context of this project, we mean people working "together to pursue complex goals based on shared interests" (McNamara, 2016, p. 65). Collaboration is often required to solve particularly complicated or "wicked problems" that benefit from having multiple groups' views and perspectives (Gray, 1985). Student success in general, but especially success for URM students in STEM, is one such "wicked problem." As stated in the introductory chapter, challenges for URM students in STEM include various academic, social, financial, and emotional difficulties that require bringing together stakeholders with various sets of knowledge and experience. These sorts of collaborations are not easy, however. As we previously noted, most campuses are very siloed, with various groups operating in isolation rather than working together toward common goals. STEM Collaboratives campuses that were able to successfully collaborate and create comprehensive programs generally incorporated several elements and practices into their processes.

We use a model of collaboration adapted from Van Winkelen (2010) to demonstrate why these collaborations were successful. Van Winkelen's model was originally developed to explain practices that sustain inter-organizational, learning-based collaboration, but it fits our findings for collaboration within organizations well. The adapted model posits that attention to three key elements can help sustain collaborative relationships and promote organizational learning: systems and processes, social ties, and power relations. In addition, we recommend Kezar and Lester's (2009) *Organizing Higher Education for Collaboration*, which documents campuses that have created collaborative environments for student success and describes alterations they made to the campus policies, practices, and value systems to accomplish this goal. Kezar and Lester's work is helpful if campuses have support from senior leadership that can alter reward structures,

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infrastructure, and policies. Van Winkelen's model requires less support from senior leadership to start working toward a collaborative environment. The CSU STEM Collaboratives initiatives we were working with did not necessarily have support for structural changes from senior leaders on campus, so this model better explained the ways the teams went about creating collaborative environments. But for this work to be sustained moving forward, we encourage campus leaders to engage with the ideas presented in *Organizing Higher Education for Collaboration*.

ELEMENTS AND PRACTICES THAT FACILITATE COLLABORATION (ADAPTED FROM VAN WINKELEN, 2010)

ELEMENT	ASSOCIATED PRACTICES
Systems and processes	Full/part time collaboration manager
	Subject knowledgeable, skilled facilitators
	Regular rhythm of activities and events
	Loose agenda at events creating space for people to raise issues and discuss emergent topics
Social ties	Social time allowed and valued for building personal relationships
	Appropriate qualifying criteria for participants
	Continuity of individuals representing their stakeholder group
Power relations	Individuals from different levels of the organization
	Efforts to reduce the visibility of differences in power between organizations or individuals
	Participative design of activities

Overview of Model Elements and Practices

To manage the dynamics of collaborative work, Van Winkelen suggests that practitioners must pay attention to several key elements. First are what she terms "systems and processes," which concern logistical and managerial aspects of collaborative work. For example, having a dedicated "collaboration manager" who can devote either some or all of their time to overseeing and smoothing the collaboration process is a key facilitator. We noted in an earlier chapter that campuses with fewer implementation challenges often had a dedicated coordinator, whether faculty or staff, who helped bridge divides and organize the logistics of the collaborative effort. These coordinators or collaboration managers must be knowledgeable in the subject matter of the collaborative work (i.e., STEM or student success generally) and skilled at facilitating meetings and building relationships. A regular rhythm of activities and events is also a critical facilitative process/system, as it keeps momentum and enthusiasm for the collaboration strong. Finally, keeping a loose agenda at meetings creates "space for people to raise issues and discuss emergent topics" that are most relevant for keeping collaborative work on track.

The second key element participants in collaborative work must attend to is "social ties," or building and maintaining relationships with collaborative partners. For example, on campuses that built meaningful relationships between student affairs, efforts were made to meet people in different offices in person rather than making requests over email, and some campuses organized informal events like lunches or happy hours to get to know one another on a more personal level. There must also be "appropriate qualifying criteria" for participants in the collaborative effort, meaning that participants must have skills, experiences, or roles that make them a good fit for the collaborative activity. For the STEM Collaboratives, this meant including STEM faculty who are knowledgeable about their discipline and the academic skills students need to succeed, student affairs staff who are knowledgeable about supports for first-generation and low-income students, and other administrative staff who manage key functions such as admissions or registration. Additionally, there must be continuity in terms of the participants in the collaboration, so that there are not new people continually rotating through, requiring new relationships to be built. Campuses that most successfully collaborated had fairly steady team membership over the course of the project.

Finally, participants in collaborative ventures must be aware of power relations, ensuring inclusion of participants at multiple levels of the organization while also reducing the visibility of differences in power between individuals or organizations. As we mentioned in an earlier chapter, teams that included faculty at varying levels of seniority, on-the-ground staff such as advisors, and more senior administrators were able to accomplish the most. Creating and facilitating activities with a participative design that encourages active and equally valued participation from all parties regardless of rank or status, helped mitigate the power differences among these participants.

In the next section, we'll return to our examples of campuses from Chapter 5, Dominguez Hills and Humboldt State, and describe how their collaborative efforts fit with this model.

Stories of Collaboration: Dominguez Hills

Systems and Processes: Dominguez Hills successfully incorporated many of the elements of collaboration described above. First, the team's leader (collaboration facilitator) was a well-respected math faculty member who dedicated a significant amount of time to managing and leading the project. His leadership style was praised by his colleagues both on the faculty and in student affairs (skilled facilitation). The team members had regular meetings where they discussed challenges, successes, and new information they had learned (regular rhythm of activities, loose agenda).

Social Ties: Additionally, we were able to observe the comfort that the team members had built with one another in our focus group with them: Every team member spoke at length, they were all enthusiastic, they laughed and joked with each other, but also were not afraid to challenge one another if they disagreed on an issue (building personal relationships). Team members remarked on the value of retaining all members of the original group in helping them develop and maintain stronger relationships (continuity of team members). They brought in the learning center, advisors, and existing SI leaders, which enabled them to provide additional support for their students outside of their courses and their summer experience (appropriate qualifying criteria).

Power Relations: The team also included faculty from different departments and student affairs staff, all at different levels of seniority (individuals from different levels). Even the least senior people on the team, however, felt comfortable sharing their expertise and getting engaged in the project because of the team leader's skilled facilitation. A more junior team member remarked how he felt "that the group reaches out to all programs and levels, including people who are boots-on-the-ground," indicating a successful effort to minimize differences in power or level among the participants in the project at Dominguez Hills (efforts to reduce visibility of power differences). His experiences as a "boots-on-the-ground" staff member brought a unique perspective to the team and enabled the members to hear feedback about how their ideas might play out in practice and what barriers might exist. Additionally, the inclusion of more senior student affairs administrators and department chairs enabled the team to get approval on key decisions and gave them champions who would advocate for their interests at higher levels of leadership.

Overall, the team members had a shared focus on student success, which facilitated their ability to work together. They remarked on their increased openness to cross-departmental work as a result of participating in the project and their belief that the relationships they had built would continue even after the grant-funded period ended.

Stories of Collaboration: Humboldt State

Systems and Processes: Humboldt State also had a great deal of success in collaborating across departments and divisions. The Humboldt team had co-PIs, science faculty who were both well-respected on campus. Like Dominguez Hills, the Humboldt project leaders were praised by colleagues for their leadership styles and their skill in motivating their colleagues and encouraging participation and buy-in from faculty and staff across campus (skilled facilitation). Humboldt also had a project coordinator, whose full-time job was dedicated to managing the project, building relationships, and handling logistics (collaboration facilitator). The PIs and project coordinator were in multiple meetings each week regarding project activities, and the larger team met weekly (regular rhythm of activities).

Social Ties: Team leaders were very intentional about who to include on the project team; they deliberated carefully about which faculty to invite to teach courses in the learning community. They wanted to choose the very best faculty who would be enthusiastic about the project, as they believed that "quality attracts quality" and that having well-respected, effective faculty participants would encourage other high performers to get involved (appropriate qualifying criteria for participants). As the scope of the project grew, the Humboldt team continued to thoughtfully incorporate the appropriate people into the project team, though the core members of the team remained constant throughout (continuity of team members). For example, the residence life director was added to the team as there was interest in increasing activities in the residence halls, and faculty outside of STEM were incorporated as their courses were added to the learning community (appropriate qualifying criteria for participants). In fact, Humboldt ended up with one of the biggest project teams because of the growing excitement around the project on campus that encouraged more people to get involved. One strategy the PIs used to build relationships was to host regular happy hours and social events, in addition to their project meetings (social time to build personal relationships). Several team members remarked on the value these social events had for strengthening relationships and breaking down barriers among faculty and staff from different departments. They also took several team members to an intensive conference on learning communities, where relationships were strengthened and previously skeptical potential partners were won over.

One Humboldt team member, in summing up the value of their collaborative efforts, stated that "the whole is stronger than the parts;" everyone working collaboratively toward a common goal produced outcomes that were better than anyone could have accomplished alone.

Power Relations: The Humboldt PIs also intentionally included colleagues at varying levels of seniority in the project, from the vice president of student affairs to adjunct faculty members (individuals from different levels). It was clear from our focus groups, which had people from various departments and in various positions, that power differences had been minimized and all project participants felt included and comfortable sharing their experiences (efforts to reduce visibility of power differences). For example, participating faculty ranged from full professors with NSF grants to adjunct instructors only a few years out of graduate school. Yet all these participants were strong contributors to the project, and their ideas were equally valued. One Humboldt team member, in summing up the value of their collaborative efforts, stated that "the whole is stronger than the parts;" everyone working collaboratively toward a common goal produced outcomes that were better than anyone could have accomplished alone.

Challenges to Collaboration

While many campuses experience a siloed environment with student and academic affairs being organizationally separated and working independently on programs and activities, the CSU system has a deeper divide between academic and student affairs built into the structures and culture of the system than many other campuses and systems. Staff who would come from other states or other campuses commented on: “the lack of communication between academic and student affairs” and “the formality and communication being very formalized with little relationship building occurring,” “being bogged down in hierarchy,” and “limited resources making collaboration challenging.” Several individuals commented—“the CSU is not ripe for collaboration.” Our observations of the challenges to collaboration were reinforced by other faculty and staff who have experiences on other campuses. The reasons for these divisions are likely many—leadership, collective bargaining, grant-funded programs, incentives, resources—and will require an examination of the policies, structures, and culture that now embed these siloed divisions that developed over time.

However, the division between academic and student affairs was the one that most affected the creation of integrated programs to support STEM student success.

The issue goes beyond just the division between academic and student affairs; there are divisions between faculty in and between units, between lecturers and tenure-track faculty, and between faculty and academic administrators. However, the division between academic and student affairs was the one that most affected the creation of integrated programs to support STEM student success. It is also important to note that many campuses struggle to connect organizational silos and divisions that can negatively shape student success. For more understanding of the historic development of the siloed bureaucracies on campuses and ways to overcome them see: Kezar and Lester’s (2009) *Organizing Higher Education for Collaboration*.

While we want to point out the real challenges that exist, we were also excited to see many campuses overcome these difficult environments and create collaborative projects that successfully supported STEM students in their first year of college.

Potential Collaboration Challenges

01

Centering the work too much on one person—while we talked about the importance of having a coordinator role, having the work rest too much on any individual often threatened broader involvement and participation among the campus community. Collaboration that creates a unified community of support requires many people to come together and meet on a regular basis. If the collaboration rests too much on a coordinator, then individuals do not see the need to meet and this broader community is not created, which is so essential to student success.

02

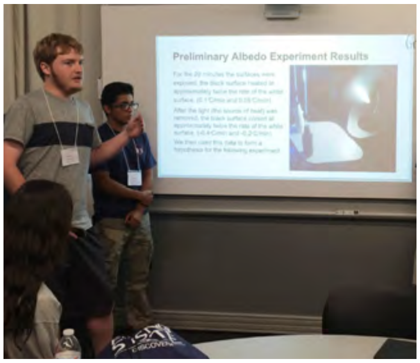
Rewards for individuals in collaborative work—our campuses have few mechanisms for rewarding individuals for being part of a collaborative effort. In particular, faculty often have no opening to report or describe work on initiatives like the CSU STEM Collaboratives in merit review or promotion. Department chairs and deans, in particular, can be helpful in creating the right circumstances for faculty involvement by providing a letter of support for a faculty member's annual report and evaluation and later tenure and promotion. Staff members, too, noted that collaboration work was always on overload and not rewarded; it is thus also important to find ways to build this work into staff roles and reward it appropriately.

03

Be aware of power dynamics and hierarchy—we noted the value of minimizing power differences, and a lack of awareness or intentional effort to do so can hinder these collaborative efforts. For example, because of their guaranteed employment, tenure-track faculty have much more power than lecturers or staff members. These kinds of collaborations are often the first time that tenure-track faculty work meaningfully with these other groups, and they do not recognize how they might silence individuals or fail to create a space where others feel they can communicate important issues to make the program successful. Therefore, it is important for tenure-track faculty to recognize the power they possess in certain situations to create a positive environment for collaboration.

STEM COLLABORATIVES

CHAPTER 7:



Implementation Challenges and Supports

Our study also sought to understand implementation challenges in creating a unified community of support for STEM students. We focus on challenges that are specific to integrating multiple programs. On the campuses we studied, we also identified general implementation issues that occur when implementing any program or change initiative; we recommend that you consider and think through these as well. They include: the importance of leadership at multiple levels, such as administration, faculty, and student affairs staff; obtaining buy-in from key stakeholders; developing a clear and compelling vision for the program; and using data to evaluate and assess programs aimed at student success. There are other guides to help with general implementation issues and we recommend Elrod & Kezar's (2016) *Increasing Student Success in STEM: A Guide to Systemic Institutional Change*.[8]

Before addressing the implementation challenges and facilitators specific to integrated programs, there are a couple of important insights to note. First, the great majority of implementation challenges reflected a lack of collaboration between different groups and units on campus. This is why we devoted Chapter 6 to review collaboration issues in more depth. It is important for campuses to understand how the current context inhibits collaboration and to gain knowledge about how to enhance collaboration. As one of the faculty members noted, "most of the implementation challenges are very doable, nothing is insurmountable, you just need to meet with the right offices, amend some policies, understand more about how the university works." Our major insight in the study is that, in large measure, implementation challenges for integrated programs just reflect a lack of collaboration. Repeatedly, we have seen that addressing student success is really about addressing the ways we work together.

Repeatedly, we have seen that addressing student success is really about addressing the ways we work together.

Second, having difficulty integrating the three interventions led campuses to be less likely to notice or capitalize on the great value of integrated programs we described in Chapter 3. Because seeing the value of the aligned interventions is related to moving toward a unified community of support, it is important that campuses address implementation issues that will prevent them from recognizing and noticing the value added.

[8] https://secure.aacu.org/store/detail.aspx?id=PKALSTSS

7

Most of the facilitators that we identified are the inverse of the challenges. For example, poor program design or team composition became implementation barriers, but, by creating a stronger program design or improving the team composition, teams can overcome all these challenges. In this section, we first describe some key issues that were both challenges and facilitators to program success. We then describe some additional facilitators that eased the implementation process that did not have parallel challenges.

Implementation Issues

COLLABORATION

Collaboration is the most important aspect of a smooth implementation process—indeed, we devoted the entire previous chapter to it. Collaboration is critical to a sound design for integrating the three programs, important to the planning team in terms of having a strong process, tied to buy-in, and responsible for helping change agents to navigate institutional policies and practices that get in the way of aligning the programs, such as prohibitions against block scheduling. Collaboration is an important facilitator, but it was also a significant barrier if not approached in the appropriate manner. Some of the practices that created the most implementation problems included emailing collaborators instead of meeting with them face-to-face, inviting key collaborators to join at the last minute, failing to understand how other offices worked, and not including the right people who have the key information to help navigate a specific logistical barrier. One faculty member noted the difficulties she had getting colleagues in other departments to participate in the program but then reflected that they were asking for participation "mostly over email…. eventually I think we got into the mindset of like this is going to take a little bit longer. So let's sit down and have a meeting with them—let's invite them to our Friday meeting and say, 'Here is what we're all about, here's what we're thinking.' And then they would be able to come with ideas, rather than like, 'We want a 20-minute presentation. Can you do that?' I think the face to face meetings were more effective at communicating what was going on and making sure we were all on the same page." A participant at another campus similarly noted the importance of effective communication when working across divisional boundaries: "…it can be challenging. And especially—
I don't think people do it intentionally, but I think [it's] the lack of time and people want to get things done. You're so used to just shooting an email and trying to do something… [but when we did that with this project] no one responded."

COMPETITION AMONG SUPPORT PROGRAMS

One of the biggest threats to collaboration was a sense of competition and threat among existing support programs. At many campuses, numerous different support programs exist for first-generation, low-income, and underrepresented minority students. Each program has a stake in supporting the students they have been working with, and their staff sometimes feel threatened by new programs that want to serve these same students. CSU STEM Collaboratives campuses that set up new programs faced the issue of competition and threat more than those that worked with existing programs. But even those that tried to utilize existing support programs for underrepresented students often found that, at first, the staff and faculty in charge of these programs were not particularly open to working with STEM Collaboratives faculty. The divide and lack of historic collaboration between academic and student affairs has led to a lack of trust. Furthermore, there are a growing number of programs for first-year students, and those focusing specifically on STEM were often seen as competing with the general first-year support programs and again not welcomed initially on many campuses.

POOR RELATIONSHIPS BETWEEN ACADEMIC AND STUDENT AFFAIRS

Strongly related to the problems of collaboration, and the sense of competition and threat, was the history of poor interaction and relationships between academic and student affairs. For example, a clash between the director of the college transition program and a faculty member at one of the campuses led to a slowdown of their work and difficulty in implementation. This problem not only manifests on teams working to implement these integrated programs but also extended to broader offices working across campuses. For example, at CSULA, when the School of Engineering reached out to work with advising, tutoring, and other support programs there was questioning (by these offices) of the intentions of faculty and staff in Engineering: “Engineering has always done things on its own. Why do they want to work together now?” There was often a distrust when academic affairs or student affairs reached out to the other group. In particular, faculty members seem to lack an appreciation of student affairs staff that has resulted in negative relationships between these groups on many campuses.

LACK OF KNOWLEDGE OF OTHER UNITS

In general, lacking knowledge about what other units of the institution do is one of the most significant implementation barriers. Faculty often made assumptions about what the registrar, orientation, admissions, tutoring, or student support offices did. Instead of meaningfully collaborating with these groups by developing relationships and taking a long-term perspective, less successful campuses often had cursory communication via email in order to implement the aligned programs and work out important details like program design, outreach and recruitment.

The campuses that had success implementing an integrated program recognized that they lacked knowledge about other units (or did not make assumptions about what other units did). Instead, they had face-to-face meetings with all their collaborators and started off by inquiring and finding out more about these offices and units, and trying to understand the ways that they might collaborate toward the creation of a new support program for STEM students. A challenge of not understanding other offices occurred at Channel Islands and impacted its recruitment and enrollment: “Records [office] wanted students to have the experience of enrolling in the sections of courses included in the learning communities and, for that reason, proposed to have students placed on a reserved list for the courses included in a learning community track. Unfortunately, this created a great challenge in getting students who verbally committed to enrolling in a learning community to actually enroll in a learning community.” In contrast, at Humboldt, faculty noted: “The most important part of implementing our program was learning more about what the various student support services and programs do. We had heard about RAMP mentors or the summer bridge program but we didn’t really have a good sense of what was involved. We met with offices, invited them to join our team, and we met really regularly getting to know the work that each other does.”

PROGRAM DESIGN

Aligning three different programs requires careful design and consideration of a variety of issues. Perhaps the most prevalent design flaw was not considering students’ outside demands (work, family, transportation, other obligations), particularly for commuter students, as teams designed the program and tried to create a cohorted experience. Many of the commuter students had five- or six-hour gaps in between courses; this made participation difficult for them and some of them dropped out of the program. Others simply could not join the program because of work obligations and courses being designated at very specific times. Commuter campuses such as Dominguez Hills, CSULA, and East Bay contended with this issue the most.

Another common design problem was not capitalizing on existing programs. Given the siloed knowledge in academic and student affairs, there were instances of faculty recreating programs that already existed on campus—summer bridge programs, first-year experience courses, or other transition programs. Not only were they reinventing the wheel, but the programs that they created often lacked the first-generation supports we noted as critical in Chapter 4, such as college knowledge and validation. For example, Dominguez Hills, Channel Islands, and Pomona all created new programs that resulted in many problems at first. And creating new programs brought a host of challenges, including recruitment and getting into the admissions and orientation processes. Additionally, faculty typically lacked knowledge about support programs they needed to link with to successfully execute a summer bridge program such as tutoring centers, writing support, career centers and the like. There were also some programs created where the issues for first-generation students were well addressed, but these largely ignored course redesign, math preparedness, or appropriate advising for first-year STEM students.

Some campuses did not deeply explore their data about students or understand enough about the issues of why students were not succeeding before designing their program. Or they had not explored their data with enough depth to design the program in a way that they could cohort students and link the program across interventions. At Dominguez Hills, team members did not recognize that students had such different levels of math readiness that they could not cohort their students as they had hoped after their summer experiences into the FYE. Unfortunately, the cohort they created in their summer bridge program had to be split up into three different groups for the fall course and the students were then mixed in with other students who were not part of the FUSE program.

Another challenge of poor design occurred when campuses tried to work with existing summer bridge or first-year experience programs, but they were not designed in ways that could be maximized for STEM students. For example, some EOP programs have very few STEM majors, so they were not a good source for obtaining the target population, as East Bay identified.

The most important element to creating a strong design from the beginning is to have adequate participation from both academic and student affairs staff so that the best existing programs are connected and leveraged. If the existing programs are deemed to not have the core supports outlined in Chapter 4, then academic and student affairs should jointly work together to design a program that carefully uses data about students and their challenges in transition and persistence to guide design decisions. And campuses should carefully resist the creation of new programs because of the many implementation challenges that ensue from starting a new program—from recruitment, to integrating it into other campus resources and structures, to making students and parents aware of the program, to involving faculty and staff. New programs also feed into the problem of competition from other programs, as noted earlier.

Campuses may not always get the right design the first year; a pilot year can be helpful in developing the most appropriate program design. Many STEM Collaboratives campuses altered their design in the second year based on data and evaluation results from Year 1. Like many campuses, Fresno tried out a theme the first year to connect its summer bridge, FYE, and redesigned courses, but it did not resonate so the team changed the theme and in the second year had a lot more buy-in across staff and faculty. Additionally, Fresno learned more about student challenges, which required a rethinking of the program: "We learned a lot more about the data and initial problem. For example, we learned that 18% of our students leave the University after the first year. An additional 14% leave our College to go to other majors—we were previously unaware of this fact. These two losses require different strategies for retention. We were concerned that our intervention is not quite aligned with the actual challenges our students face and our college faces in terms of retention."

TEAM COMPOSITION AND DYNAMICS

To create an intervention that aligns programs that cross the boundaries of academic and student affairs requires a team that has a balance of staff in student affairs and key faculty in academic affairs. Teams also needed to have faculty and staff on the ground close to students' needs, but also some more senior administrators who could help the planning team in overcoming policy challenges that emerged. The most successful teams that were part of the CSU STEM Collaboratives included some key administrators who helped open doors with admissions to facilitate recruitment of students into the program and, who in turn made block scheduling possible. But many teams lacked the right staff, faculty, or administrators necessary to appropriately implement the program and develop knowledge of other units, address policy changes, workload, and issues highlighted throughout this section.

Another implementation challenge within teams was lack of development and teambuilding. Given that the planning teams need to bring together individuals who typically do not work together, there is often little knowledge or understanding of each other's work. Without some sort of process to have faculty and staff better understand each other's work, it is likely that implementation problems will ensue. As one staff member said: "I think we all make assumptions about others' roles and what we do and what our jobs are and I think being able to have conversations about those things and going, "Oh, wow, I had no idea faculty had to do all of those things or had all of those expectations…is really valuable…[but also, unlike faculty] we don't have release time…for us, it is what it is, you have to figure out how to manage it [on top of your other work]. It's important, so you make it happen…" In response to that comment, a faculty member noted her assumption that staff work schedules were similar to those of faculty members: "I as a faculty in the past maybe I'd be going, oh, everybody's got to work late. Now you get a sense, no that was special [when staff worked late], you should be very respectful of it. It's rude but you can get into that mode sometimes."

Campuses that successfully overcame these challenges put intentional time and effort into building relationships across these boundaries. For example, the Humboldt team hosted happy hours, had team members attend conferences together, and met regularly to build camaraderie.

WORKLOAD

Aligning several programs in support of students requires additional workload in terms of meetings among faculty and staff who work with each of the interventions. To create a feeling of a professional cohort or learning community, faculty and staff across various interventions need to be in communication, but this adds on work that institutions currently have no formal mechanism to address. Though some faculty had buy-outs through the grant, many STEM Collaboratives faculty and most staff generally took on this work on top of all of their other work. Thus, sustainability is a problem unless the issue of workload is addressed by the institution.

None of the campuses identified ways to address the workload issue beyond the life of the grant. The most significant implementation issue that needs examination is how we organize our institutions and how current workload models do not incorporate any type of collaboration. Fresno describes this challenge and a potential solution: "Current policy for allocating WTU [weighted teaching units, used to calculate faculty workload] is course-centered, assigning a fixed number of units per course regardless of the number of instructors. A more faculty-centered approach would recognize the actual effort from each faculty member in a collaborative team, which requires much more planning and coordination, not just in teaching but in all aspects of course management—and therefore more time for meetings in addition to in time spent in class. A more supportive policy would 1) compensate each faculty fairly with full WTU for their efforts, 2) remove the worry about increased workload deterring new faculty from joining the FYE, and 3) help meet the effective faculty: student ratio recommended for GE courses." The structured pathways and freshman interest groups and all these aligned programs will face the same issues around workload. Getting integrated programs off the ground is the most work, but maintaining them will mean some time collaborating to keep the connections going.

INSTITUTIONAL POLICY OR PRACTICES

As noted earlier, our institutions are set up in silos and those silos get embedded into policies. The first siloed policy that created implementation challenges relates to disciplines and supporting interdisciplinary teaching. As we described earlier, in order to link three separate interventions, many of the campuses used a theme or activity that utilized interdisciplinary problem-solving, such as climate change, sustainability, or environmentalism. To take advantage of these interdisciplinary themes, some STEM Collaboratives campuses planned their redesigned courses and first-year seminars as team-teaching experiences. However, some CSUs or particular colleges and departments within them are unwilling to support team teaching in terms of workload.

The next policy relates to block scheduling. To create a cohort experience, campuses need to block schedule students in a series of courses; however, this proved difficult on many campuses because of existing registration policies. Relatedly, while many campuses wanted to offer priority registration to STEM Collaboratives students as a motivator to participate in the program, some campuses had difficulties working with the registrar's office to make this happen. Some policies on campuses blocked or made it difficult to get a new STEM-related FYE course to count for GE credit. At Fullerton, existing advising practices made the new intervention challenging as advisors were unwilling to counsel students to take the newly cohorted courses. Humboldt described the way it worked to address policy challenges identified: “Two policies that would ease block registering students include: (1) letting students know at the time of admission to the HSU whether or not they are also accepted into their selected (impacted) major, and (2) enabling students to take the MDTP test (to confirm eligibility for calculus) well before arriving to HSU. We first needed to identify these challenges and then adopting policies along these lines was immediately beneficial.”

Campuses were better able to address institutional policies if they have administrators involved in the planning team who could have an impact on altering registration policies, GE and curriculum policies, admissions practices, faculty workload policies, chair scheduling and other issues that emerged that impacted implementation. The campuses that got most bogged down in implementation challenges typically did not have an administrator on the team or access to administrators to facilitate alteration of institutional policies. There is a lot of synergy between many of the implementation issues.

ASSESSMENT AND EVALUATION OF MULTIPLE PROGRAMS

Complex programs are particularly hard to assess. All CSU STEM Collaboratives campuses engaged in evaluations but found it extremely challenging to disentangle the effects of the summer experience from the FYE and the redesigned first-year courses. Campuses struggled to find control groups to compare and even when they did, they often found the control group had some type of different experience, which meant that they were not as clean a control as hoped. For example, at Fresno, students in the control group ended up taking much less rigorous math courses; this meant they had higher GPAs then the treatment group and artificially made it look as if the treatment group was not as successful even though the treatment group had been taking much more advanced math to prepare them for their STEM courses. So, evaluations of these type of complex programs need to be thoughtfully and carefully designed to most effectively measure impact. Project teams also ran into challenges of some students not continuing throughout all three experiences and not being able to attribute certain development to specific interventions. Dominguez Hills described some evaluation challenges: “FUSE freshman students have not all have had the same kinds of experiences, which makes the evaluation of the project’s success more complicated.” Given that having positive outcomes is so important to implementation in terms of buy-in, administrative support, and sustainability, these challenges of evaluating a multipronged, integrated program are important to consider up front.

Campuses typically overcame the challenges related to assessment and evaluation by carefully choosing an evaluator who had skills in this specific type of evaluation. If they had a strong partnership with their institutional research (IR) office, these staff could help them in choosing evaluators who might be more likely to successfully evaluate the program. In addition, IR offices can provide reports related to persistence, GPA and other data that they track within the institution to assist with the assessment efforts. Strong assessment data was a great facilitator of implementation as the story of Humboldt suggests; one faculty member “taught this general botany class for many years, and he works really hard on his craft, and teaching, and takes it personally when the students aren’t very successful, and has tried a lot of different things. And then this thing comes along and it has this big effect [on retention]. And he stood up there in front of the whole college and said, ‘I basically didn’t do anything different in the classroom. It was the way it was structured that had this big bump [in success].’ And then…it’s like ‘Wow. OK. I’ve done all these things to my syllabus to try to improve over the years. Now we just change how it all fits together—not just my class, but all the other pieces—and it has a bigger effect than any tweak to the syllabus ever.’”

Facilitators of Implementation

A few practices that facilitated implementation emerged that were unique from the challenges that we highlighted in the section. The first is the issue of *differentiated messaging* in order to create collaboration that resonates across many different groups. Humboldt recognized that it needed to reach out to faculty, administrators, staff, parents, and students with different messages about the need for and benefits of an aligned support program. Faculty got excited about interdisciplinary and field-based research, staff really resonated with working with the community, and parents really liked the idea of classes guaranteed to count for students' majors. When trying to have multiple groups buy in to a particular program, you must understand people come from different motivations and message it differently to these various groups.

Another facilitator was having some sort of *coordinator role*. Sometimes this was a staff person who could keep track of all the different programmatic elements and set up all the different meetings across faculty and staff groups. At other campuses, it was a faculty member or two who took on the role. These individuals can be proactive about logistics as well as community building. Many of the campuses also utilized STEM VISTAs to support program administration.

Broader Systemic Challenges in the Teaching and Learning Environment at the CSU

We conducted a survey at the beginning and end of the project that asked faculty and staff about attitudes, values, and institutional conditions for supporting pedagogical change and implementing HIPs. This survey did not specifically ask about conditions for integrated programs or collaboration. However, survey results show that some of the barriers to implementing HIPs or pedagogical change are similar to the implementation challenges for integrated programs we reviewed in this chapter. Below are some of the key systemic barriers to improving teaching and learning at the CSU that emerged from our survey:

- Faculty across all eight STEM Collaboratives campuses indicated that promotion and tenure policies at their institutions do **not** support improving classroom instruction.
- No campuses support instructional improvement through annual merit pay.
- While some faculty did indicate that their department chairs value teaching improvement, there seems to be little professional development at the departmental level that supports this value and inconsistent availability of departmental mentoring to support instructional improvement.
- There are few classrooms and facilities on campus that promote the kind of evidence-based, active pedagogies that support the most student learning.

Our survey results demonstrate that faculty at CSUs actually have a lot of knowledge about evidence-based pedagogies and HIPs and that they value these practices; it is institutional constraints that are inhibiting more meaningful change on our campuses.

For more information on how campus administrators can better support teaching improvement and other HIPs, see our article in Liberal Education here: https://www.aacu.org/liberaleducation/2017/winter/kezar_holcombe

And access a tool to support self-reflection on current levels of support for HIPs here:
http://www.uscrossier.org/pullias/wp-content/uploads/2016/06/HIPs-for-Admins-Tool-Formatted.pdf

STEM COLLABORATIVES

CHAPTER 8:

Key Takeaways and Recommendations

The STEM Collaboratives project filled several significant gaps in the STEM student success landscape. By focusing on the freshman year for STEM students, the program was able to support students in their introductory STEM courses, the point at which many students, especially those traditionally underrepresented in STEM, typically become discouraged and switch majors or drop out. Additionally, by connecting several high-impact practices (HIPs) across students' first year, the programs were able to provide seamless, high-quality learning experiences for students. Finally, by bringing together important sets of knowledge and expertise from both STEM faculty and student affairs, the program was able to create a unified community of support for students during their transition to college, both inside and outside the classroom. In this final chapter, we review several key takeaways and provide a set of recommendations for both the CSU system and other campuses and systems interested in strengthening their support for STEM students in their first year.

Key Takeaways

Several key findings emerged from this study of integrated programs to support STEM student success. First, this project demonstrated that there are two key sets of knowledge that are necessary for success in STEM for underrepresented students. These sets of knowledge already exist on campus (although they may not be widespread among faculty and staff), but they are siloed in student affairs and academic affairs and rarely come together. Student affairs staff are knowledgeable about the needs of first-generation, low-income, and URM students, such as lack of validation or sense of belonging, while STEM faculty are knowledgeable about STEM-specific challenges, such as inadequate math preparation or appropriate timing of courses. Unfortunately, most existing support programs for underrepresented students in STEM only target one or the other set of needs. The STEM Collaboratives project, in bringing together faculty and student affairs staff, capitalized on both sets of knowledge and created programs that comprehensively addressed students' needs.

Second, there was immense value in creating these integrated programs that incorporated high-impact practices and included both faculty and student affairs staff. The most successful programs created a unified community of support felt by both students and faculty/staff. Students felt that everyone they encountered was on the same page and working together to support their success, and faculty and staff felt that they had common goals and were part of a larger community dedicated to the same things.

Third, there are some implementation challenges that are unique to creating these sorts of integrated programs. These include poor relationships between academic and student affairs, lack of facilitative policies and workload to support collaboration, poor program design, inappropriate team composition, difficulties with program evaluation, and lack of knowledge about key campus functions, among others.

Fourth, as might be expected given the project's name, collaboration was a crucial factor in determining the success of these programs. Campuses that successfully collaborated paid attention to important systems and processes, encouraged formation of social ties among participants and built trust, and minimized power relations.

Finally, one of our biggest takeaways from this project was the fact that the specific high-impact practices (HIPs) implemented by each campus did not really matter; there is no magic in a summer bridge, first-year experience, or redesigned course in and of themselves. Rather, the value of this program came from integrating these interventions to create a cohesive educational experience for first-year STEM students and from the unified community of support that resulted from this integration.

As the system engages in future efforts such as the Graduation Initiative 2025, many recommendations from this project can help support meeting the goals of these new initiatives. Without a deeper examination of campus structures, policies, rewards, data capacity, and connection to the lived experience of students, these initiatives may not achieve their objectives.

Recommendations

In this final chapter, we also offer recommendations for better supporting first-generation, low-income, and underrepresented minority students in STEM. To make a significant difference in the persistence and graduation rates of these students, this initiative and our study suggest the following:

1. BRIDGE THE DIVIDE BETWEEN ACADEMIC AND STUDENT AFFAIRS

The organizational siloes that exist between academic and student affairs present the greatest barrier to the success of students. This silo-ization is within the control of campus leaders. We must find more ways to bring together student affairs staff and STEM faculty if we want to improve success for students who have been historically underrepresented in STEM. Each group has knowledge and expertise that is pivotal for helping these students succeed, but without communication and collaboration these knowledges remain locked in their siloes. Campus leaders should think about ways to bridge these siloes and ensure that multiple voices are at the table when strategizing about the best ways to support students.

Relatedly, Daryl Smith noted that higher education institutions suffer from "program-itis." This is the belief that we can resolve problems by creating more and more programs, rather than by looking at underlying causes for issues around student success. This project shows that rather than creating yet another programmatic intervention, what we really need to do is have existing units across both student affairs and academic affairs work more closely together in service of student success. Our report suggests many ways to bridge the divide, from the creation of learning communities, to joint work, restructuring through guided pathways, interdisciplinary centers, and technology such as e-portfolios and early alert systems.

2. ALTER INSTITUTIONAL POLICIES AND PRACTICES THAT WORK AGAINST COLLABORATION

Campus leaders need to look carefully at policies that deter collaboration and make it difficult for various units to work together and create a seamless learning experience. Block scheduling was an example of a policy that made it difficult for each campus to create a seamless learning environment. Lack of rewards for co-designing curriculum together was another area. In addition to altering policies that deter collaboration, campuses also need to examine and create policies and practices that help facilitate collaboration. For example, merit reviews might include collaboration as an explicit area for which people are rewarded. Campuses might create professional learning communities and consortia that bring together groups across traditional work boundaries. For a detailed review of policies and practices that can be altered to facilitate collaboration see Kezar and Lester (2009).

3. RETHINK WORKLOAD AND REWARD POLICIES FOR FACULTY AND STAFF TO SUPPORT COLLABORATION

Workload policies stood out as particularly prohibitive to collaboration across all campuses. To promote collaborative ways of working on campus, it is absolutely critical for leaders at the campus and system levels to rethink workload policies and the ways that rewards and incentives as currently structured may be hindering collaboration. The current design of faculty and staff roles and policies related to workload ignore the importance of collaboration. For example, we learned that STEM Collaboratives team members struggled to incorporate team teaching because of workload policies that would not give each instructor full credit for teaching the course. We do not recommend that all courses should be team taught—that would be expensive and unnecessary for many courses. However, campuses should be able to experiment with such structures for certain courses without penalizing participating faculty. Additionally, both faculty and staff who undertook collaborative work did so on top of their existing duties; there were no additional rewards or incentives outside the limited lifespan of the grant, and faculty could not count their project work toward promotion and tenure. Further, campuses that tried to create the sorts of interdisciplinary courses that incorporate real-world problems and engage students ran into policies that essentially punished departments that tried to create such cross-listed courses.

Important developments in these areas are occurring across the country. For example, the New American Colleges and Universities have developed collaborative evaluation systems and guidelines for academic departments to operate in a more collaborative way and reward this collaboration (see report at http://newamericancolleges.org/what-we-do/publications/). Models such as this should be used and adapted to create workload policies that support collaboration. Leaders must reevaluate workload policies if they truly believe in the value of collaborative work.

4. FACILITATE FACULTY INVOLVEMENT IN STEM SUCCESS INITIATIVES

Contracts, structures, and rewards prevent faculty of all appointment types from participating in STEM success initiatives. Many of the faculty involved with these initiatives were part-time faculty and lecturers who teach a great majority of the remedial and introductory courses in STEM. These faculty members had difficulty participating in course redesigns because of time constraints based on the nature of their appointments. Additionally, many of the department chairs and faculty leaders involved with the project noted that tenure-track faculty lacked incentives or motivation to participate in curricular redesign efforts, outside of limited grant funding. Our survey suggested that involvement in curricular redesign and improving teaching is not rewarded by CSU campuses. Incentive systems need to be examined so that they are aligned with student success. Part-time and lecturer faculty contracts also need to be examined for ways they can facilitate faculty involvement in curricular redesign and student support programs, such as summer bridge.

Many STEM Collaboratives campuses had success engaging faculty in professional development as part of this initiative and this was noted as part of the value added. Faculty development in this project differed from some of the traditional efforts aimed more narrowly at pedagogy. Clearly pedagogical training was important to redesigning courses and improving the learning environment, but the project underscored other important knowledge for faculty related to understanding their students and understanding other support services and divisions on campus as critical elements of faculty development.

5. TAP INTO PROGRAMS ON CAMPUS THAT ALREADY WORK WITH STEM OR FIRST-GENERATION ISSUES

When undertaking a new STEM initiative, campuses should examine their existing landscape of student support programs and determine where they can integrate and collaborate to take advantage of existing resources. Many strong programs already exist on most campuses, and existing pockets of expertise should be leveraged. Additionally, existing support services for first-generation, low-income, and underrepresented minority students are a wealth of knowledge when it comes to serving these student populations. The overall system does not have a good mechanism for tapping into and sharing the knowledge developed among these various programs. Sometimes the directors of these programs get together themselves, such as LSAMP, but the overall system does not provide a vehicle for support programs to inform student success initiatives as much as it could. Cal Poly Pomona has undertaken an effort to bring these support programs together on a regular basis through various consortia. These consortia hold regular meetings for the leaders of the various programs that serve either first-generation, low income, and underrepresented minority students or STEM students to learn from each other and combine forces where possible. Pomona also has a vision of expanding this system so that these groups then communicate with others on campus about student success. We need to share the knowledge held in these offices more within each CSU campus and across the system.

6. USE DATA TO INFORM PROGRAM DESIGN AND REDESIGN

Each of the STEM Collaboratives campuses was required to use data about student persistence, graduation rates, and other success indicators to inform the creation of their initiative. However, each campus was required to implement three specific, predetermined high-impact practices (HIPs)—summer bridge, first-year experience, and redesigned courses. For future projects, campuses should thoughtfully examine their institutional data to determine what their students' needs are before implementing any particular HIP and build partnerships with IR offices. For example, if most students are commuters and work full time during the summer, a traditional summer bridge program may not be the most effective solution. HIPs are not one-size-fits-all, and some are better suited to particular types of campuses or student populations. STEM Collaboratives campuses were also required to conduct evaluations that helped some of them reshape their intervention between Years 1 and 2, if necessary. The use of data to design and alter the programs was extremely important to their success. We encourage the system to continue to use data to inform decision-making and student success efforts. Additionally, the use of data is vitally important to report that an intervention works, especially the use of rigorous analyses for internal reporting purposes. STEM faculty, perhaps in particular, can be compelled or motivated to use a new approach through data.

7. TALK TO STUDENTS

Students often know and can communicate their concerns and needs. It does not appear that there is enough communication and exploration with students about their own educational pathways and their perceptions about the best ways to help them succeed. While the system has benchmarking systems that provide quantitative data about student trends, there appear to be limited data sources that identify the nature and quality of students' experiences. The system would benefit from creating mechanisms for students to share their experiences and recommendations. Focus groups and other means of collecting qualitative data should be conducted for the system on a more regular basis. Other state system offices such as the UC system utilize qualitative methodologies to understand the student experience. We also recommend that the system office work with individual campuses to enhance their abilities to collect this data to inform their decision-making. Lastly, campuses might consider adding students to campus teams aimed at creating programs and interventions for student success.

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ACKNOWLEDGEMENTS

We wish to thank the tireless collaborators in the California State University System for their work on this project. Their leadership, creativity, willingness to experiment, and commitment to students was an inspiration as we studied the project over the last three years. We are also grateful for the expertise and advice of our esteemed advisory board members, who supported the campus teams in this challenging work, as well as the Helmsley Charitable Trust, which provided financial support.

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FUNDERS

This project was made possible by a generous grant to the California State University System from the Leona M. and Harry B. Helmsley Charitable Trust. We benefited in particular from the thought partnership of our program officers, Ryan Kelsey and Sue Cui.