Chapter 10

A Collaborative Professional Development Program for Science Faculty and Graduate Students in Support of Education Reform at Two-Year Hispanic-Serving Institutions

David R. Brown,[*,1] Stacey Brydges,[2] Stanley M. Lo,[3] Maya E. Denton,[4] and Maura J. Borrego[5]

[1]Foundation for California Community Colleges, Sacramento, California 95811, United States

[2]Department of Chemistry and Biochemistry and Program in Mathematics and Science Education, University of California San Diego, La Jolla, California 92093, United States

[3]Section of Cell and Developmental Biology, Division of Biological Sciences and Program in Mathematics and Science Education, University of California San Diego, La Jolla, California 92093, United States

[4]Department of Mechanical Engineering, University of Texas at Austin, Austin, Texas 78712, United States

[5]Department of Mechanical Engineering and Center for Engineering Education, University of Texas at Austin, Austin, Texas 78712, United States

[*]E-mail: drb.stem.ed@gmail.com

Emerging revelations from education research have underscored strategies which effectively promote student success in undergraduate science courses. This chapter describes a pilot professional development for science educators in higher education aimed at implementing these strategies at two-year Hispanic-serving institutions (2Y-HSIs). Science faculty members from 2Y-HSIs and graduate students at a research university participated jointly in the collaborative professional development activities described herein. The design of this unique program that comingles in-service and pre-service educators was informed by prior research: Enduring change in science education necessitates more than simply informing educators about effective instructional approaches. Following a comprehensive three-day workshop focused on restructuring college science courses via backward design, 2Y-HSI faculty members and graduate student partners worked together over the next year to devise, implement, and assess the impact of interventions intended to promote active learning in classrooms at the 2Y-HSIs. In support of this effort, the graduate students received additional training on how to conduct classroom observations and provide effective feedback to the 2Y-HSI faculty. A community of practice was further cultivated via regular project meetings that enabled participants to share progress, exchange ideas, and solicit advice and guidance. A culminating session, during which the 2Y-HSI

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faculty member-graduate student teams presented posters of their ongoing work, offered a capstone experience. In this chapter, we invite faculty members and administrators from two-year colleges (2YCs), especially 2Y-HSIs, and research universities to consider the potential of such collaborative professional development efforts.

Introduction

This chapter describes a work in progress with an emphasis on the design, implementation, and assessment of a collaborative professional development program for two distinct groups of science educators within the sphere of higher education: current faculty (in-service educators) at 2Y-HSIs and prospective future faculty (pre-service educators) who are graduate students in science disciplines at a major research university. Although the two distinct groups of participants may be at different points along their respective career trajectories, they are not taking part in segregated, specialized professional development activities. Instead, the participants are collaborating jointly to transform science courses at 2Y-HSIs, with a particular emphasis on incorporating evidence-based, active-learning pedagogies. Our project aims to contribute to the literature in professional development for higher education faculty, while simultaneously addressing the growing need of a diverse STEM workforce and the critical role of 2Y-HSIs in higher education.

U.S. Demographics and the STEM Workforce

In the past 50 years, the U.S. has seen seismic shifts in its demographic composition, which have considerable implications for the STEM labor force. It is important to examine population statistics and workforce participation by race and ethnicity to set forth the context that connects the evolving national demographic and STEM labor force. Of particular significance to this project is the Hispanic population. According to the National Science Board (*1*), the non-Hispanic White population accounted for 65.6% of the U.S. population of age 21 and over in 2015, and they filled 66.6% of the STEM occupations. In contrast, the Hispanic population made up 14.9% of American residents over 21 years of age but were only responsible for 6.0% of the STEM occupations (*1*). These data clearly indicate that the Hispanic population is currently substantially underrepresented in the STEM workforce, and unless strategic and effective measures are taken, the situation will likely worsen.

The Hispanic population has undergone dramatic increases in both absolute numbers and relative proportions of the residents in the U.S. In 1970, the U.S. population was approximately 203 million, with the Hispanic population accounting for 9.6 million or 4.7% (*1*, *2*). By 1990, with the U.S. population reaching approximately 249 million residents, Hispanic residents numbered 22.6 million or 9.1%, nearly doubling their contribution in a 20-year span (*2*, *3*). In 2016, the Hispanic population reached approximately 58 million or 18% of the U.S. population of approximately 323 million (*2*, *3*). Hispanics made up half of the population growth in America between 2000 and 2016 (*2*). Conversely, the non-Hispanic White population in America is the only group declining in population, both in absolute numbers and in percentage. U.S. Census Bureau projections (*4*) suggest that the population of non-Hispanic Whites will decline from approximately 198 million or 61.3% of the population in 2016 to 179 million or 44.3% of the population in 2060. By 2045 there will be no majority ethnic or racial group in the United States (*4*).

In addition to the broader evolution of the U.S. demographic, the nation's STEM labor force is aging. In 1993, the median age of the STEM workforce was 40 years old, and by 2015, the median age had increased to 43 years old (*1*). Furthermore, in 1993, the percentage of individuals in the STEM workforce between ages 51 and 75 years was 20%, while by 2015, that subset had risen to 33% (*1*). Thus, the non-Hispanic White population constitutes the lone segment of the American demographic that is declining in numbers while also being the predominant group filling occupations in a STEM labor force that is aging. The confluence of these factors confers an urgency to increase participation in the STEM workforce by all groups, with special emphasis on those historically underrepresented, in order to maintain the competitiveness of the U.S. in the global STEM enterprise.

Two-Year Hispanic-Serving Institutions

According to the American Association for Community Colleges (*5*), in 2018, there were 1,103 2YCs in the U.S. The majority of these 2YCs (980 out of 1,103) were public institutions, and they served 7.1 million students, which represented 41% of all undergraduates, including 52% of all Hispanic undergraduates (*5*). Various accounts have been given to the contributions of the nation's 2YCs to the STEM enterprise (*6–8*), such as developing the skilled technical workforce (*9*) and broadening underrepresented minority participation in STEM (*10*), especially including specific focus on Hispanic students and graduates in STEM (*11*). In 2016, 492 institutions were designated as HSIs (defined, in part, as having >25% Hispanic enrollment), serving over two million Hispanic students, and 44% of these institutions were public 2Y-HSIs (*12*). Because of the evolving Hispanic population in the U.S., the number of HSIs has experienced rapid growth, increasing from 189 in 1994, to 229 in 2000, to 245 in 2005, to 311 in 2010, and to 492 in 2016; the number of HSIs doubled in the 11 years between 2005 and 2016 (*12*). Further, in 2016, another 333 institutions were designated emerging HSIs, defined as having Hispanic student enrollments between 15.0% and 24.9%, approaching the 25% minimum Hispanic enrollment required as part of the HSI designation (*12*).

Efforts to produce STEM graduates in numbers sufficient to instill future confidence in our nation's ability to remain competitive in international STEM endeavors have experienced headwinds, and 2Y-HSIs are uniquely situated to address these challenges. For every 10 students who enter post-secondary education with the intention of majoring in a STEM discipline, fewer than four actually earn a degree in STEM (*13*). For students enrolled in STEM programs between 2003 and 2009, by the spring of 2009, 48% of the four-year bachelor's students and 69% of the two-year associate's students had exited a STEM major (*14*). Attrition in undergraduate STEM majors occurs via two mechanisms, switching to a non-STEM major and dropping out of college altogether (*14*). Research has revealed factors that predict attrition, such as the number and level of rigor of STEM courses taken during the first year and extent of successful outcomes in both STEM and non-STEM college-level courses (*14*). Other work has indicated the significance of success in the first two years of post-secondary STEM education as being critical to retaining students to degree completion, and the experiences of students should be improved by promoting evidence-based classroom practices such as active learning (*13*). With their diverse student demographics, 2Y-HSIs are natural places where it is possible to engage many learners historically underrepresented in STEM.

Reform in Undergraduate STEM Education

In the past few decades, many national reports have called for the transformation of undergraduate STEM education (*13*, *15*, *16*), especially for diverse students across different educational contexts (*9*, *12*). These recommendations are based on the research of how people learn (*17*, *18*) and empirical evidence on the success of various active-learning pedagogies (*19*, *20*). Among the large-scale instructional strategies that have emerged from different STEM disciplines are Process Oriented Guided Inquiry Learning (POGIL) (*21*), Student-Centered Active Learning Environment with Upside-down Pedagogies (SCALE-UP) (*22*), Science Education for New Civic Engagements and Responsibilities (SENCER) (*23*), Consider, Read, Elucidate the hypotheses, Analyze and interpret the data, and Think of the next Experiment (CREATE) (*24*), and National Center for Case Study Teaching in Science (NCCSTS) (*25*). A myriad of other active-learning interventions - of different scale and intensity - have also advanced student achievement in STEM classrooms (*20*). At the same time, it is recognized that course redesigns should be informed by further research on the type of active learning that is most effective for different topics and diverse populations of learners, among other factors (*20*).

Tied to these educational reform efforts (and the inertia of replacing didactic practices) is the support that could benefit the faculty who are transforming their STEM classes (*26*). In recent years, professional development programs with a focus on many of the aforementioned pedagogical approaches have been put in place for faculty across STEM disciplines at various institutions (*27*, *28*). In parallel, national professional development programs within and across disciplines have emerged, such as Cottrell Scholars Collaborative New Faculty Workshop (*29*), On the Cutting Edge (*30*), Summer Institutes on Scientific Teaching (*31*), and the Center for the Integration of Research, Teaching and Learning (CIRTL) (*32*).

A Collaborative Professional Development Program

Our professional development program is distinct from others in the existing literature: Both in-service and pre-service educators across science disciplines collaborate to develop, implement, and assess active-learning pedagogies in the classroom. Our program combines the advantages of other existing programs by bringing together educators at different career stages and across disciplines into one community of practice (CoP) (*33–35*). This CoP framework describes a group of people ("community") with a shared craft or profession ("practice"), with an emphasis on learning that is situated in the real-life context of the practice. Here, we define teaching as the practice and professional development as learning from the perspectives of the pre- and in-service educators. In this framework, learning is understood as increasingly sophisticated participation in the community of practice, rather than the mere acquisition of knowledge and skills. Newcomers to a community (pre-service educators) become more experienced in the practice by participating in activities that veterans (in-service educators) also perform ("legitimate"), even though the newcomers' level of expertise may be less sophisticated ("peripheral"). Through this legitimate peripheral participation, newcomers move to more central positions in the community as they develop their own expertise in the practice.

Research has shown that advances in STEM education requires more than educators learning about teaching strategies, and effective and sustainable change needs a combination of multiple elements: developing curriculum and pedagogy, fostering reflective educators, developing shared vision, and enacting policy (*36*, *37*, *38*). Our professional development activities were designed with these aforementioned aims and a framework that aligns with the core ideas of CIRTL, for which the focus to date has been graduate students at research universities: learning-through-diversity, teaching-as-research and learning communities (*32*). The 2Y-HSI faculty and graduate student partners collaborate to develop, implement, and assess the impact of new curricular materials. Regular meetings are structured to promote reflections on teaching and shared vision on the whole project. While we are not explicitly enacting policies, NSF funding and ongoing national conversations about change in STEM education provide a larger impetus for our work. In consideration of both the historical and anticipated growth of 2YCs and HSIs, what is learned in this project has potentially broad implications for informing others dedicated to promoting STEM student success across different types of institutions, not just 2Y-HSIs.

The impetus for partnering the 2Y-HSI faculty and graduate students was multi-fold. First, there is precedent for graduate students supporting both K-12 (*39*) and university-level science course innovations (*40*) but not 2YC reforms. We posit that graduate students could contribute to such efforts at 2Y-HSIs in similar or analogous ways, via troubleshooting, consultation, and collaborative engagement. Second, graduate students interested in academic careers at 2YCs have very few opportunities to prepare for these roles, and we posit that 2Y-HSI faculty could provide graduate students with both mentorship and early access to such a classroom teaching experience. Finally, since many undergraduate students transfer from 2YCs to universities, there are opportunities to bolster their preparation and pathway. We posit that real and lasting change in STEM education could be effected through programs such as this one that build capacity, connect people, and strengthen institutional ties.

Program Participants

Ten community colleges situated across San Diego and Imperial Counties in California (the counties that form the border with Mexico) comprise the set of 2Y-HSIs from which the faculty members were recruited. The home institution to the graduate student participants is the University of California San Diego (UC San Diego). The project leadership team consists of STEM faculty with foci in education research and practice: the PI is from one of the 2Y-HSIs, two co-PIs are from UC San Diego, and the third co-PI is from the University of Texas at Austin.

The 2Y-HSI faculty were identified and invited by project leaders, based on the following criteria: motivation to participate, including the identification of a potential active-learning project; commitment to working with a graduate student on their course redesign; and plans to advance diversity in teaching. Ultimately, the 2Y-HSI faculty who were selected for the project represent a range of disciplines and years of teaching experience. Cohort 1 consisted of eight full-time faculty from chemistry (5), biology (2) and physics/astronomy (1). Cohort 2 was expanded to include faculty in earth sciences (2), in addition to chemistry (2), biology (2), and physics/astronomy (4); 6 of 10 also held part-time, adjunct status. As contingent faculty teach a significant portion (>50%) of college courses and have fewer professional development opportunities than their full-time peers (*41*), improving student learning in the environments they create is no small contribution to the STEM education enterprise. Furthermore, part-time faculty members often teach at more than one college, which offers the potential to propagate the impact of our professional development initiative and active learning interventions in an even greater diversity of settings.

Graduate student recruitment efforts focused on outreach in coordination with departmental graduate chairs and coordinators, as well as the Teaching and Learning Commons (The Commons) at UC San Diego. To match faculty teaching discipline foci, the project leaders targeted graduate students in similar research areas (chemical, biological, and geosciences, as well as physics and astronomy). Besides a demonstrated interest in education and the support of their M.S./Ph.D. advisors, prospective participants were expected to have fulfilled their discipline-specific graduate teaching requirements, which is typically 2-4 academic quarters as Teaching Assistants (TAs) in undergraduate lecture and laboratory classes at UC San Diego. This ensured a degree of prior teaching experience and accompanying TA professional development. Amongst the 10 successful graduate students (5 per cohort), 7 had also completed the 10-week graduate-level course, "Introduction to College Teaching" (*42*), which aligns with the core ideas and mission of the CIRTL Network (*32*) and is offered by education specialists at The Commons at UC San Diego.

Ultimately, interdisciplinary collaborative teams of two 2Y-HSI faculty (from different institutions) and one graduate student were assigned by the project leadership team. These teams joined together for scaffolded professional development over the course of a year, as described next.

Professional Development Activities and Timeline

Three primary program activities framed professional learning in the context of course redesign over a sustained duration of a year. Our program launched with a Course Design Studio (CDS), followed by project meetings each semester and a poster symposium the subsequent August (coinciding with the next program cycle). In the intervening times, each 2Y-HSI faculty and graduate student team maintained regular contact and established its own schedule of online and in-person meetings, including campus visitations by the graduate students.

Course Design Studio

Facilitated by education specialists from The Commons at UC San Diego, the CDS is a comprehensive, 3-day workshop that uses the backward design framework (*43*) to guide faculty through the process of developing a course that fosters an inclusive environment for which student-centered learning outcomes (day 1), assessments (day 2), and active learning experiences (day 3) are aligned (*44*). Interestingly, our project presented the first occasion for the CDS to be adapted to community college faculty as teaching practitioners and graduate students as partners in college science innovations. Modifications that were made to meet the needs of these participants are described in the next section on formative program assessments.

During the CDS, participants were given time to revisit and discuss in further depth the following: (1) What course and which part do you intend to redesign? Why? What is already published in this area? (2) What are the ways you will engage as colleagues, and by what means and frequency will you communicate? (3) How might the project leadership team support you in this process? What additional information and resources do you need at this stage?

While the work to reform the pedagogical methods and materials of a course is itself demanding, establishing the role of a graduate student (from another institution, no less) who can be a dedicated partner in the curriculum development, implementation, and assessment processes can be an added challenge (*40*). Previous research has shown that the collegial engagement of graduate TAs in innovative undergraduate science education is fostered by professional preparation, regular meetings with faculty, and faculty receptiveness to critique and suggestions (*40*). But it is neither an innovative or conventional faculty-TA relationship that unites program participants (i.e., the graduate students are not assigned to work as TAs), and so teams must themselves define the dimensions and boundaries of their shared work and responsibilities. This topic was addressed explicitly, and program participants were provided with examples of collaborative activities that align with and support the course transformation process:

1. Learning outcomes: Brainstorm desirable undergraduate student outcomes beyond the stated learning objectives, e.g. engagement, interests, mindset, motivation, science process skills, etc.
2. Formative assessments: Identify ways to making undergraduate student thinking visible or ascertain student understanding, skills, and attitudes via classroom assessment techniques (CATs). Consider the use of educational technologies to gather this feedback.
3. Summative assessments: Identify appropriate assessments for undergraduate student outcomes in lab and lectures. Write exam questions to better align with more cognitively demanding learning objectives, and/or consider different testing strategies.
4. Activities: Peruse the primary literature and adapt or devise new active-learning activities, including polling questions, inquiry-based lab or lecture modules, case studies, POGIL materials, and more. Consider having the graduate student serve as a guest instructor for a class or two, depending on availability, expertise, and interests.
5. Reflection: Plan for the graduate student to conduct a classroom observation, and/or to conduct informal discussions with undergraduate students about their learning experiences.

In support of this latter activity, the graduate students received additional training via The Commons, examining the purpose of formative peer review, the biases of reviewers and the goals of reviewees, and the basic steps to a review (i.e., the pre-observation dialogue, the review itself, and the post-observation dialogue, documentation, reflection and decision-making). From an active learning vantage, this session provided the graduate students with practice on making observations without assumptions and giving effective feedback (*45*).

Regular Program Meetings

Project meetings were typically held once per semester at one of the local 2Y-HSI campuses. Having HSI faculty serve as meeting hosts reinforced participants' shared commitments and common experiences, while showcasing the resources and learning spaces of 2Y-HSIs. Ultimately, these meetings helped to establish a more encompassing vision of the professional development, to foster community, to build capacity, and to maintain participant's motivation. The 2Y-HSI faculty and graduate student teams provided progress reports, discussed challenges, and requested input on a myriad of issues, from specific course design elements to the validated instruments they might use to assess the impact of course reforms. The meetings also served as an opportunity for participants to gain further exposure to education research, either through an invited speaker or a guided discussion of a recent publication.

Annual Poster Session

As a culminating experience and a platform for recognizing each 2Y-HSI faculty and graduate student team's ongoing course transformation efforts, the program hosts an annual poster session at UC San Diego. At the program onset, participants are provided with a poster template (Figure 1) that emphasizes the backward design model (*43*), with question prompts accompanying each of the five sections: course and student background; learning outcomes (pre- and post-reform); formative and summative assessments (pre- and post-reform); learning experiences (pre- and post-reform); and, reflections on implementation and practice. For example, in outlining a student-centered active learning activity, participants are asked to consider: (1) Have others in the peer-reviewed literature had success with this or a similar activity? (2) How have you adapted it to your course or institution?

(3) What was the role of the instructor and the undergraduate students before, during, and after the activity? What questions did you anticipate your students would have? What guiding questions did you prepare to ask? What technology, demonstrations, simulations, models or analogies did you incorporate? (4) How did the activity promote an inclusive classroom?

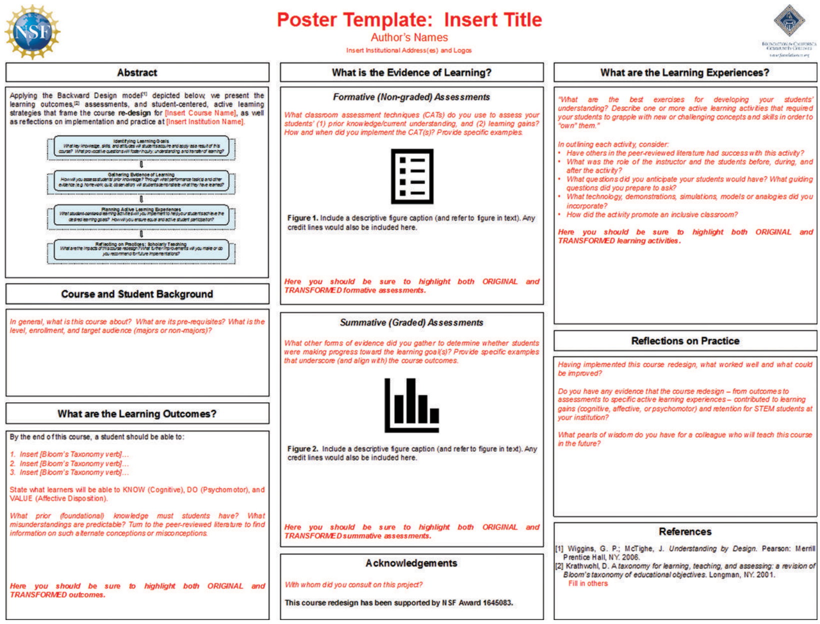

Figure 1. Poster template used by teaching teams to frame their course redesign project. Designed by Stacey Brydges and adopted from a graduate-level TA professional development course (CHEM 509) at UC San Diego.

At the poster session, teams present their scholarly work. In addition, all participants engage in "birds of a feather" discussions based on shared interests, and develop a deeper sense of community with the entire project group, including the CDS education specialists, as they share lunch.

Formative Program Assessment

Our professional development program is currently in its second cycle, with the second cohort of 2Y-HSI faculty and STEM graduate student participants collaborating on their course redesign projects. Here, we summarize the ongoing formative assessment results that have continued to inform the implementation and modification of our program. Specifically, we report preliminary data on the CDS organized at UC San Diego, regular follow-up meetings hosted at 2Y-HSIs, the annual poster session, and focus group feedback.

Course Design Studio

Following the first CDS in January 2018, several changes were made to enhance workshop design and implementation for the participants in the second cohort. These modifications were based on feedback from the post-CDS evaluation forms, informal observations, and both written and verbal feedback solicited from the first cohort. The post-CDS evaluation included items with

Likert-type scale responses (on a 1 to 5 scale, with 1 = poor and 5 = excellent) and questions with open-ended responses. Results from the Likert-type scale responses from both cohorts of 2Y-HSI faculty members and UC San Diego graduate students are summarized below (Table 1). Of note, participants indicated that insufficient time was provided to work on their course redesign projects (average = 3.69) and that the facilitators of the CDS proceeded too quickly through the provided material (average = 4.08).

Table 1. Post-CDS evaluation on a scale of 1 = poor to 5 = excellent.

	Cohort 1 (N=13)	*Cohort 2 (N=15)*
General CDS organization	4.31	4.73
Appropriateness of schedule pacing	4.08	4.47
Overall importance of topics	4.46	4.60
Quality of content	4.38	4.53
Opportunities to be actively engaged	4.54	4.80
Organization of sessions	4.23	4.67
Communication skills of presenters	4.54	4.71
Amount of time for your planning work	3.69	3.93
Opportunities to interact with other participants	4.62	4.80
Opportunities to get feedback from facilitators	4.38	4.67

Through both formal and informal assessment methods, participants from the first CDS cohort shared their thoughts and concerns related to their involvement in the CDS and, more broadly, the full measure of the professional development project. Prior to their participation in the workshop, almost all of the faculty participants were unfamiliar with STEM discipline-based education research (DBER) and the associated literature. Aligned with our teaching-as-research goal, both 2Y-HSI faculty and graduate students expressed a keen interest in further learning about the existing body of research.

In response to this feedback, we changed the CDS schedule for the second cohort to provide more time for the 2Y-HSI faculty and graduate student partners to discuss teaching practices and common classroom issues. Furthermore, 2Y-HSI faculty participants were paired with their graduate student partners throughout the duration of the CDS to facilitate team building. In terms of the content of the CDS, attending to diverse student identities at 2Y-HSIs became an overarching focus, and we explored how personal identity influences teaching and learning, drawing upon audience-specific experiences and examples in both institutional settings and fostering relationship building among 2Y-HSI faculty and graduate student partners. We also added two sessions on current STEM education research efforts by the project leadership team, speaking about instruction methods in introductory biology courses and student resistance to active learning. These sessions provided deeper context for and connection to the project goals and helped to reinforce the importance between scholarly teaching and the scholarship of teaching and learning. As seen in Table 1, all 10 measurements in the post-CDS evaluation results for the second cohort increased with the implemented changes. As all curriculum development is an iterative process, the experience of the first cohort provided lessons upon which to build a more sustainable and valuable CDS model for 2Y-HSIs.

Regular Follow-up Meetings

As noted above, participants reported on their ongoing course redesign - progress and challenges - at regular project meetings throughout the academic year. The most salient and recurring issues that emerged during these sessions had to do with the nature of the collaboration between 2Y-HSI faculty and graduate students, the need for more resources on active-learning pedagogies and associated DBER scholarship, and the ethics of human subject research in relation to studies embedded in the project.

In response to the feedback for more structured collaboration between the 2Y-HSI faculty and graduate student partners, we modified the program organization in the second year to ensure that both groups of participants began working together from the very beginning at the CDS. Teams based on science disciplines were formed, and time was dedicated at the CDS for the teams to map out their respective collaborations. Because each team had unique contexts and different needs, we maintained a relatively flexible project structure without dictating the exact collaboration for each team. Instead, we focused on the goals and outcomes of the professional development project and relied on each team to determine their best course of action.

For the other feedback, we compiled and shared a variety of resources with the participants, including a list of evidence-based, active-learning pedagogies, peer-reviewed journals related to education research and practice, and DBER and education conferences at which participants could potentially present their work. We also created a project blog that features recent work in discipline-based education research from various STEM disciplines, with the goal of expanding access to primary literature for our 2Y-HSI faculty participants whose institutions may have limited resources to journal subscriptions. Blog posts are written by the project team and graduate students to emphasize the cross-disciplinary nature of the professional development project.

Annual Poster Session

Collaboration between 2Y-HSI faculty and graduate students in the first cohort resulted in eight distinct course redesign projects that implemented evidence-based, active-learning pedagogies across a variety of disciplines. These works-in-progress were presented at the annual poster session, where both cohorts were in attendance.

As an example of these projects, in an introductory chemistry course, students were expected to be able to: name inorganic compounds, predict the products of different types of chemical reactions, and solve stoichiometry problems. In class, students were engaged in real-time discussions through a gamified personal response system called Kahoot (*46*) and worked collaboratively through problems using the "scratch-off" immediate feedback assessment technique (*47*). The graduate student partner tracked the level of student engagement through in class using a modified version of the Behavioral Engagement Related to Instruction (BERI) protocol (*48*), and students reported that the diversity of activities improved their understanding of the material.

In an electricity and magnetism course for STEM majors, revised learning objectives emphasized that students would be able to: connect different concepts related to electricity and magnetism to explain naturally occurring phenomenon; correctly measure voltage, resistance, and current in a circuit; and draw electric and magnetic field lines for given charge and current distributions. Course materials were redesigned to include evidence-based, active-learning activities such as think-pair-share, as well as a series of activities to help students develop metacognition. These included an exam planning scaffold that asked students to consider how best to prepare for exams and how to distribute responsibilities and roles in the two-staged group exams. Overall, students reported that the active-learning components allowed them to understand the material better, the course structure held them accountable for their own learning, and they learned and developed skills for other aspects of their lives.

In a non-majors biology course, revised learning objectives challenged students to develop a more robust understanding of the diversity of life on Earth. For example, students were required to use their knowledge of cell structure, cell division, gene expression, cellular respiration, and photosynthesis to explain the unity and diversity of organisms. Classroom activities were redesigned to include clicker questions and scaffolded group worksheets to promote student interactions and discussions. The graduate student partner observed that learning objectives were clearly laid out for each class, clicker questions allowed students to engage and discuss concepts with one another, and student participation was high and not concentrated just at the front of the classroom.

Focus Group Feedback

At our first annual poster symposium, we collected feedback from the first cohort of participants in the form of a structured focus group. Participants were asked the following four questions:

- What was the most rewarding and beneficial part of the project?
- What were the biggest challenges?
- What advice do you have for the next cohort?
- What do you need next from the project team?

Both 2Y-HSI faculty and graduate student participants reported the following benefits: meeting and connecting with like-minded people (in a community of practice), gaining awareness of and practice with new teaching methods, and observing changes in student engagement and learning that result from active-learning interventions. In addition, 2Y-HSI faculty participants found it useful to reflect on their own teaching and student learning in their courses. Graduate student participants appreciated the opportunity to have faculty mentors at 2Y-HSIs, to witness teaching at 2Y-HSIs, and to learn about classroom observations from workshops provided by The Commons.

Surprisingly, participants reported few challenges beyond the amorphous nature of the collaboration between faculty and graduate students, an important point that also emerged from the regular follow-up meetings. The biggest obstacle experienced by participants was the lack of time to develop thoughtful and meaningful activities; this is a common issue when designing and implementing active learning (*31*). The lack of time was often exacerbated by the physical distance between the partnering institutions; in particular, one of the 2Y-HSIs is over 100 miles away from the San Diego metropolitan area.

The advice for the next cohort centered largely around the implementation of evidence-based, active-learning pedagogies in the classroom, such as setting the tone for active learning on the first day of class, reminding students about the purpose of classroom activities and approaches, having a well-defined plan and timeline for implementation, and starting small without trying to change everything all at once. An interesting observation was that participants requested resources for use beyond the first year that have little overlap with what they perceived as critical for the first year. For example, participants expressed interest to learn more about how to assess student learning that may result from their current work, including concept inventories that measure cognitive achievement, standardized surveys for student experiences and affect, and advice on statistics and comparison groups for meaningful data analysis. This divergence of advice for the first year and resources needed beyond the first year suggests that faculty professional development is a long-term journey with multiple stages, where the participants may have different needs along the progression.

Conclusions and Future Work

In this chapter, we report the progress of designing, implementing, and assessing a collaborative professional development program for science faculty from 2Y-HSIs and graduate students from a neighboring research-intensive institution. Thus far, we have attempted to address important issues surrounding educator professional development, such as the need for extended engagement beyond one-time workshops, hands-on work that moves from mere description of teaching skills to reflective practice, and a learning community or CoP that empowers educator changes and institutional reform (*49*). Specifically, in our project, we examined the challenges and benefits of adapting the CDS from a four-year institution for 2Y-HSI faculty, as well as partnering graduate students with 2Y-HSI faculty to support implementation and assessment of active learning in gateway STEM courses.

Moving forward in the project, we will continue to examine the impacts of the professional development program on not only the 2Y-HSI faculty and graduate student participants but also undergraduate students in the classrooms at 2Y-HSIs. Specifically, we aim to address the following research questions:

- How, if at all, do 2Y-HSI faculty and graduate student participants change their conceptions of teaching, learning, and diversity from their engagement with professional development?
- How, if at all, do the specific course redesigns contribute to increased learning and persistence for undergraduate students at 2Y-HSIs?
- What are the critical components that make this type of professional development (and associated communities of practice) sustainable beyond its initial grant funding?

While our project centers around faculty and curriculum development at 2Y-HSIs, our findings should be of interests to faculty and administrators from a wide range of institutions, from 2YCs (not only 2Y-HSIs) to different types of four-year colleges and universities. We invite our readers to consider the potential opportunities and benefits of such collaborative professional development efforts.

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