

Developing and Sustaining Faculty-Driven, Curriculum-Centered Partnerships Between Two-Year Colleges and Four-Year Institutions

By Charles J. De Leone, Edward Price, Mel S. Sabella, and Andrea G. Van Duzor

Recent reports have highlighted the varied and complicated paths STEM (science, technology, engineering, and mathematics) students often take to graduation, which may include attending multiple institutions and increased time to degree. These issues can be addressed, in part, by better coherence between institutions of higher education, such as two-year colleges (TYCs) and four-year colleges and universities. This article presents a cross-case comparison of two faculty-driven partnerships between TYCs and four-year institutions. Outcomes include impacts on individual faculty and increased coherence across the partnering institutions, resulting in course and program transformation, evolution of faculty identity and roles, better coherence and alignment across institutions, and faculty participation in national dialogue surrounding educational transformation. These two partnerships developed and operated independently, but common features include a concrete programmatic focus; regular, equitable discussions between faculty from different institutions; participation of faculty from institutions with similar missions and values; and initial external funding. These cases illustrate how faculty-driven, nonhierarchical, and discipline-based partnerships can facilitate faculty growth, while increasing coherence between two- and four-year institutions in an effort to better serve STEM students.

What does it take to support students through the complicated pathways they take to achieve undergraduate degrees in science, technology, engineering and mathematics (STEM)? The recent report *Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways* (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2016) brings attention to today's STEM students' often varied and complicated paths to graduation, which may include attending multiple

institutions, stopping and restarting, and taking more than 4 years to attain a degree. This finding is of broad interest to faculty, policy makers, university administrators, and students because of the high costs of attrition and increased time to graduation. In response, the *Barriers and Opportunities* report and other calls have advocated for better coherence between structures within our higher education system such as two-year colleges (TYCs) and four-year colleges and universities (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2016; President's Council of Advisors on

Science and Technology [PCAST], 2012). Efforts to support interinstitutional partnerships (see note at end of article) such as transfer agreements are an important contribution to coherence in higher education, but often lack faculty perspectives, engagement, or development mechanisms. We contend that faculty-based partnerships, which can take the form of faculty learning communities (Cox, 2004) or cross-institutional collaborations, can leverage faculty strengths to promote coherence between institutions, as well as support faculty development and curricular improvement. It is therefore important to understand the characteristics of effective, faculty-level collaborations, as well as how different types of institutions can create and sustain effective partnerships.

This article presents a cross-case comparison of two partnerships between TYCs and four-year institutions in Southern California (in the San Diego metro area) and Chicago. We detail the partnerships' structures and examine key elements for effective collaboration. In these examples, we present an analysis of how university and TYC faculty partner together to enact meaningful change to improve educational outcomes for STEM students and allow smoother transitions for students between institutions. Our focus is not on the outcomes of the individual partnerships,

which have been reported elsewhere (Cochran, Duzor, Sabella, & Geiss, 2016; De Leone, Price, DeRoma, Turpen, & Sourbeer, 2016). Rather, we present a cross-case comparison focused on understanding the key elements and features of the partnerships themselves, with the aim of determining the elements that may be transferable to other interinstitutional collaborations.

Cross-institutional partnerships

Faculty improvement efforts such as faculty learning communities can scaffold the development of reflective practitioners, ultimately leading to course and program improvement. As our work began to involve TYC colleagues, we hoped that faculty-driven partnerships between institutions could serve this professional development role, as well as foster shared vision and build cross-institutional coherence at the departmental and course level. Such partnerships, we suspected, could powerfully support STEM student success given the nonlinear paths students navigate between TYC and four-year institutions (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2016).

Minority-serving TYCs “enroll a disproportionately higher portion of their focal populations than do other two-year institutions” and play “a critical role in promoting minority transitions from two- to four-year institutions, especially in STEM fields” (Nguyen, Lundy-Wagner, Samayoa, & Gasman, 2015). Given our particular opportunities to work with minority-serving TYCs, we hoped that such partnerships would support minority student success in particular.

Partnering across institutions can be mutually beneficial because both university and TYC faculty have valuable contributions to offer

and are committed to serving and supporting their respective student populations. University faculty can gain the expertise of TYC faculty’s deep understanding of the strengths and needs of a student population that is often more diverse than at four-year institutions. This is especially important given demographic trends in the United States and calls for higher education to better support students from underrepresented minority groups or who have lower socioeconomic status (see, e.g., National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2011, which highlights the role of TYCs and minority-serving institutions [MSIs] in this effort). Two-year college faculty can gain access to opportunities and resources, such as grants, release time for noninstructional activities, professional development, and educational research expertise, that are more common at four-year institutions.

We also acknowledge likely barriers to such partnerships. Differences in institutional missions, structures, and tenure and promotion priorities may complicate efforts to develop shared goals and agendas. Partnerships between multiple institutions may tend toward a unidirectional, hierarchical structure, particularly when two- and four-year institutions are involved. Differences in institutional classification (number and type of degrees awarded, extent of research activity, admissions selectivity, etc.) can result in perceived differences in status. This can lead to the four-year institutions setting and controlling the agenda when developing research, curricular, or policy resources. For instance, transfer agreements often center on aligning TYC courses so students are prepared to transfer to a four-year institution. Other initiatives have sought to increase coherence between these institutions by having four-year institutions provide research capacity

for TYC faculty (e.g., Hirst, Bolduc, Liotta, & Packard, 2014; Phelps & Prevost, 2012). This primarily serves as an attempt to mold TYC faculty and student experiences without significantly impacting the four-year institutions and the faculty at four-year institutions. This approach does not leverage the strengths of the TYC community, which include knowledge of teaching and support for their specific students, as well as the specific disciplinary knowledge of TYC faculty.

Curricula change efforts across institutions have been described in previous work and can illustrate the diverse types of collaboration that exist among faculty and institutions. Curricular change was a focus of both the Southern California and Chicago partnerships, though other outcomes were observed and are described later. The literature indicates that, frequently, a small group of faculty develop and disseminate curricula, while other faculty constitute potential adopters. Henderson, Finkelstein, and Beach (2010) described such curriculum change efforts as *prescriptive*. In prescriptive approaches, characterized as development and dissemination strategies, a few experts develop materials and give the products to other faculty. For instance, this may involve a specific curriculum, developed and tested at a research university, which is then implemented at a comprehensive college (Sabella, 2002). Henderson et al. (2010) highlighted two main issues with linear, prescriptive models: (a) “there is no meaningful role for typical faculty to play in the change process” and (b) they do not account for differences in environments and structures where faculty work. These prescriptive approaches to curriculum change fail to leverage faculty knowledge of their own students and institutions. Analogously, we identify some of the same failings in unidirectional,

hierarchical partnerships between institutions. Partnerships that follow a prescriptive model are common but are often not effective because they tend to ignore the complex structures and cultures at diverse institutions (Corbo, Reinholz, Dancy, Deetz, & Finkelstein, 2016).

In contrast, *emergent* curriculum change efforts operate at the level of individual faculty by developing reflective practitioners (Henderson et al., 2010). Again, we apply this concept in the context of institutional partnerships. Nonhierarchical faculty relationships emphasizing emergent outcomes (which we refer to as “heterarchical”) provide an alternative to unidirectional, hierarchical partnerships established to accomplish prescribed outcomes.

Heterarchical faculty partnerships between institutions have the

potential to foster mutual growth and utilize the diverse strengths, expertise, and experience of all partners. Such partnerships can provide space for diverse strategies and value all participants, recognizing that different participants have expertise in different areas. This equitable approach informed our engagement in partnerships between TYC and four-year faculty, as described next.

Partnership descriptions

Our university and two-year college partnership examples come from the San Diego metropolitan area in Southern California and from Chicago. These partnerships were established separately and operated independently of each other. In both partnerships, science and mathematics faculty (including the authors) were the primary collabo-

rators across institutions. The work centered on curricular improvement in introductory science and math courses and the implementation of a peer teaching assistant model, called the Learning Assistant (LA) model (Otero, Finkelstein, McCray, & Pollock, 2006; Otero, Pollock, & Finkelstein, 2010). On the basis of grant evaluation measures including increased use of student-centered, research-based curricular materials, increased number of presentations and publications, and institutional support, both partnerships were highly successful (Cochran et al., 2016; De Leone et al., 2016). Figure 1 indicates the institutions and approaches in each partnership.

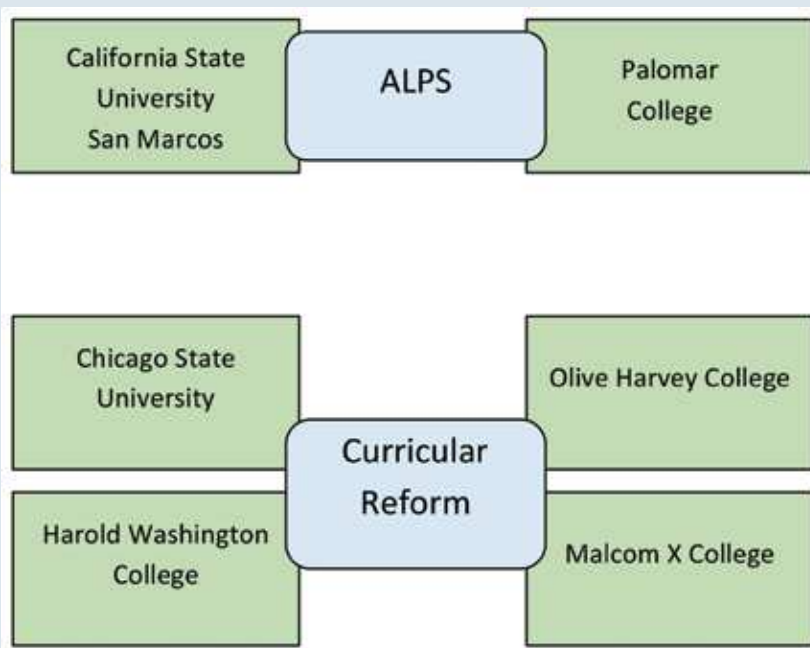
Southern California partnership

California State University San Marcos (Cal State San Marcos) and Palomar College (Palomar) began a formal collaboration in 2012. The Active Learning Pedagogy Support (ALPS) program is a cross-institutional, discipline-based, faculty learning community that draws participants from Cal State San Marcos and Palomar. Cal State San Marcos and Palomar are Hispanic-serving institutions (HSIs) located within 3 miles of each other in north San Diego County, with large numbers of students transferring from Palomar to Cal State San Marcos. ALPS program goals include increasing the success rate of students in gateway STEM courses at both institutions, increased awareness and coordination between instructors, and more STEM transfers between institutions. The ALPS program was initiated through funding from the National Science Foundation (NSF) STEM Talent Expansion Program (STEP).

The first ALPS group focused on introductory chemistry courses and the second on precalculus and calculus. The groups included a mix of Cal State San Marcos and Palomar tenure

FIGURE 1

The Southern California and Chicago partnerships both feature four-year universities and two-year colleges collaborating with heterarchical partnerships through implementation of learning assistant (LA) programs and research-based pedagogies. ALPS = Active Learning Pedagogy Support.



track and lecturer faculty (8–10 total in each disciplinary group) who met every 2 weeks for two semesters. One semester was spent exploring evidence-based instructional practices and planning the implementation of such practices in participating faculty's classes; the second semester was spent implementing these practices with the help of undergraduate learning assistants (LAs; Otero 2006, 2010). The groups were responsible for scheduling the meetings, choosing topics of interest, and exploring discipline-based education research results and research-based instructional practices/curriculum. Faculty were provided a stipend for their participation in the program.

Chicago partnership

Since 2007, physics faculty from three of the City Colleges of Chicago have partnered with faculty from Chicago State University (Chicago State) to improve introductory physics student success at their institutions through changes to programs, curriculum, and instruction. Three physics faculty from Harold Washington College (Harold Washington) and Olive Harvey College (Olive Harvey) began collaborating with Chicago State in 2007, and the fourth faculty member, from Malcom X College (Malcom X), began discussing instructional reform with Chicago State in 2011. To achieve this goal, the collaboration supported the implementation of research-based instructional strategies, curriculum development, and the creation of a multi-institutional LA program. The four institutions involved in this partnership are diverse MSIs and primarily serve the populations in Chicago in which they are located on Chicago's Southside (Chicago State and Olive Harvey), Westside (Malcom X), and downtown (Harold Washington).

Initially, the partnership worked to implement and assess research-

based instructional strategies in introductory physics courses with funding provided by an NSF Course, Curriculum, and Laboratory Improvement [CCLI] grant (2007). Funding from the American Physical Society PhysTEC (2010) program supported the development of LA programs at Chicago State, Harold Washington, Olive Harvey, and Malcom X and funded students at these institutions to become LAs. More recently, the collaborating faculty at Harold Washington and Malcom X are leading efforts at their respective institutions to create sustainable, internally funded LA programs. These programs build on TYC strengths and create opportunities for TYC students to engage in teaching experiences and support students enrolled in courses. Although the partnerships began with a focus on local changes, faculty at Chicago State and Harold Washington have since broadened the focus of their contributions, for instance co-leading regional workshops in Chicago for the national LA Alliance (Cochran et al., 2016). Faculty from the Chicago partnership still often meet formally (at institutions) and informally (at coffee shops) to discuss education and how to best serve the students at their institutions. Current efforts are supported by Department of Education Predominantly Black Institution and NSF Improving Undergraduate STEM Education (IUSE) grants, as well as the individual institutions.

Methods and study design

In an effort to explore the structural elements that support effective partnerships, we conducted comparative case studies of the successful collaborations of the Southern California institutions and Chicago institutions. The goal of this study was not to reach generalizable conclusions (Lincoln & Guba, 1985); rather, the aim was to determine the types of supporting structural elements that

may be transferable to other inter-institutional collaborations.

Following IRB protocols, semi-structured interviews were conducted with participating faculty and administrators at all sites. The cases were originally designed as independent studies, and thus there is some variability in data collection. For instance, in the Southern California partnership, interviews were conducted by the external evaluator, whereas in Chicago, the interviewer was a participant–observer of the project (Glesne, 2015). Although the interview protocols were worded slightly differently, the underlying questions were very similar. Both collaborations sought to answer the same questions about effective partnerships. Interview questions included ideas such as “What is your role in the collaboration?” and “How has the collaboration benefited you and your institution?”

Initial analysis of each case was done independently, but recognition of common themes led us to instigate a comparative case study of the two sites (Cochran et al., 2016; De Leone et al., 2016). The comparative case study was conducted collaboratively by four-year institution faculty from each partnership with a focus on common outcomes and mechanisms that supported the efforts. This analysis went beyond surface features such as logistics to look for coherence in assumptions about collaboration, programmatic structures, and outcomes between the two projects. Data were reanalyzed using a theoretical framework of emergent change (Henderson et al., 2010). Due to differences in institutional reward systems and expertise, the TYC faculty chose not to actively participate in research. However, TYC faculty did provide voice through member checking, where participants review the research findings, which also serves to establish credibility of the results (Lincoln & Guba, 1985).

Findings and discussion

In comparing the Southern California and Chicago partnerships, we note common circumstances including shared geographic service areas, admissions selectivity, and student populations among the institutions within each partnership. Similarly, institutional missions and faculty reward structures that value teaching and learning are also shared. All the schools involved in both the Southern California and Chicago partnerships are MSIs.

Cross-case comparison also identified shared fundamental features that were designed into the partnership structures. In both cases, the partnerships were cross-institutional and discipline based. Both projects had external funding, began as faculty-driven collaborations, and operated at the faculty and course level with the goal of improving student outcomes.

Both collaborations described here were anchored by specific, focused curriculum-improvement efforts as TYC and four-year institution faculty implemented research-

based instructional strategies with the support of a multi-institutional LA program. In this article, we focus on the role of the partnerships' emergent, nonhierarchical natures and the benefits this confers (summarized in Table 1), instead of presenting the curricular and student outcomes that resulted from this work. More information on the curricular outcomes in each partnership is provided elsewhere (Cochran et al., 2016; De Leone et al., 2016).

ALPS was designed to bring faculty together to collaborate on learning about and implementing research-based instructional strategies rather than asserting that one side of the partnership has the "right" answers for curricular reform. Specifically, the ALPS program did not endorse or recommend a particular curricular reform; rather, participants were encouraged to select an option of their choosing. One of the participating faculty in Southern California (an adjunct at the four-year institution) enthusiastically embraced active learning and the LA model philosophy and explored vari-

ous interactive learning strategies, including clickers, flipped classrooms, and small-group problem solving. These curricular changes led to improved student outcomes in introductory calculus. He noted, "A lot of my effectiveness is due to LA support and support from the [ALPS] program. . . . It is the epitome of a win-win situation." The percentage of students withdrawing or receiving grades of D or F (DFW rate) in this instructor's calculus course decreased by 21 percentage points from the two semesters before ALPS to the two semesters after ALPS and the introduction of LAs. In surveys and interviews, the majority of participants indicated that they were supported by the collaborations to make changes that they otherwise would not have undertaken.

The Chicago partnership began with a well-defined curriculum reform effort, yet faculty still collaborated to mutually improve implementation. This required overcoming the barriers posed by institutional type and faculty roles, which affected participant perceptions. For instance, some Chicago TYC faculty initially assumed Chicago State faculty were "in charge" because they had secured the grant funding. Chicago State faculty intended to pursue a more collaborative relationship and instead sought to bring in all participants' expertise into the project. The supportive environment precipitated TYC faculty's perception that they could leverage their experience at an MSI to develop curriculum that better serves their students. In explaining his motivation for these efforts, one Chicago TYC faculty member mentioned that "I think it would be nice if our role was expanded not just as the laboratories of curriculum reform, [rather] partly being responsible for some of that curriculum reform . . . what can we do that's specific to us to improve the state of physics education."

TABLE 1

Summary of outcomes related to partnership activities.

Area	Outcomes
Faculty development	Engaging in reflective practice; Implementing research-based instructional strategies
Evolution of faculty identity and roles	Establishing and sustaining local LA programs; contributing to national dialogue on STEM education
Course transformation	Adopting research-based instructional strategies; adapting these to local setting and student population
Program transformation	Institutionalizing LA programs
Better cross-institution coherence/alignment	Growing faculty awareness of expectations, courses at partner institutions; developing relationships with faculty at other institutions

The faculty participants in these partnerships had different levels of expertise with research-based instructional strategies and discipline-based education research, and initially not all members of the partnerships saw themselves as equal contributors. However, faculty at individual sites later took on new leadership roles, which we attribute to continued, intentional recognition of participants' diverse expertise, and which led to stronger partnership relationships. For instance, the four-year institution faculty had more initial exposure to the LA model, and it was natural for them to take an initial leadership role in the cross-campus LA program. However, the LA programs at each institution are now led by faculty at that institution, which takes advantage of their better understanding of the learning resources and needs of their students and the affordances and constraints of their institutions. TYC faculty in Chicago led efforts to institutionalize the use of the research-based instructional strategies and the LA programs. Two of the three partner Chicago TYCs are implementing their own institutional LA programs; faculty at Harold Washington have co-organized and co-hosted regional workshops and participate in leadership roles within the LA Alliance, helping to shape the direction of the national program. Meanwhile, Chicago State has also been able to expand their LA program from physics to six STEM disciplines. Although the faculty at the Chicago TYCs and Chicago State now operate their own, independent LA programs, they continue to collaborate and support each other's programs, leveraging the local partnership network to inform each other's work. Similarly, Palomar faculty participated in the Cal State San Marcos LA program, which placed Cal State San Marcos students as LAs at Palomar. Later, Palomar began its own Teaching

and Learning seminar and operating its own LA program. Implementing LA programs provided a context for deeper discussions of teaching and learning for all faculty.

As the experience with LA programs indicates, these partnerships also had impacts at the departmental or institutional level. One type of impact relates to institutionalization. For instance, in Chicago, faculty at the two TYCs and Chicago State, who were part of the original curriculum development project, voluntarily utilize many of the same research-based instructional strategies for classroom and instruction laboratory activities that were introduced at the beginning of the partnership 10 years ago. In some cases, faculty have made adaptations to the original materials, adopted additional materials from other sources, or developed new materials. In all cases, faculty were still using materials in the spirit of the student-centered, inquiry-based approach advocated in the partnership/grant. This story of successful institutionalization emphasizes the ownership the participants have for the curricula and implementation.

Other impacts relate to alignment between programs at the partnering institutions. For instance, Cal State San Marcos and Palomar faculty gained an improved understanding of the programs at the partner campus and how courses transfer and articulate. As one Palomar faculty member described, "I now have a better understanding of how the math courses work at Cal State San Marcos. I have more familiarity with it and a better understanding of how similar their curriculum is to ours. I didn't realize it was that similar." This is important because courses that officially articulate for transfer credit do not necessarily provide similar preparation in practice. A participant commented, "I could help convey to our students that it will be highly similar when they get there

and point out where there might be some subtle differences and to help smooth their transition." Following the ALPS programs, STEM student transfer rates from Palomar to Cal State San Marcos increased by 55%, from 55 to 85 (3-year averages before and after start of partnership; De Leone et al., 2016).

In sum, these heterarchical, faculty-driven partnerships allowed space for diverse strategies and valued all participants, recognizing that different participants have expertise in different areas. Creating heterarchical partnerships was an intentional strategy on the part of the four-year institution faculty in each partnership. Collaborators equitably drove the project and shared a common agenda. They also brought varied expertise to the table, which was necessary to achieve project goals. Through participation in the partnership, faculty were observed to grow in the service of improving their practice.

We point to a number of outcomes related to the partnerships' heterarchical nature, which are listed in Table 1. The Southern California and Chicago partnerships impacted individual faculty and increased coherence across the partnership institutions, resulting in course and program transformation, evolution of faculty identity and roles, better coherence and alignment across institutions, and faculty participation in national dialogue surrounding educational transformation. Discourse through the heterarchical structure of the partnership increased Palomar faculty confidence in Cal State San Marcos programs. TYC faculty recommendations to students, in concert with the multi-institutional LA program, led to increased transfer rates. TYC faculty in the Chicago partnership began contributing to national conferences and collaborations around the LA program and voiced their broader educational interests.

TABLE 2**List of circumstances and designed elements common to the two partnerships.**

Common circumstances in each partnership	Common elements designed into partnerships
Physical proximity between partner institutions	Discipline-based, cross-institution, faculty-driven
Institutions have strong regional ties	Emphasis on curriculum and pedagogy
Partner institutions enroll similar student populations	Diverse faculty expertise intentionally valued
Partners are minority-serving institutions	External funding for partnership activities
Similar institutional missions and faculty reward structures	Focus on a research based instructional model

Reflections and implications

The recent *Barriers and Opportunities* report calls for greater coordination between elements of the higher education system. Developing effective partnerships requires understanding the complex collaborative higher education ecosystem and seeking opportunities where all members can contribute and are motivated by shared values, objectives, and commitments. We identify a number of key elements in the success of the Southern California and Chicago partnerships—some deriving from the circumstances of the institutions involved, and others designed into the partnerships (see Table 2). Shared circumstances include physical proximity, strong regional ties, enrollment of similar student populations, and being MSIs. Additional circumstances relate to the institutions' core features including shared values on teaching and learning and institutional emphasis on teaching for promotion and retention. These similarities provided a common language and led to similar overarching goals for the collaboration. Whether more disparate institutions can easily create heterarchical, productive part-

nerships remains an open question. Lessons learned from our partnership case studies can inform many types of collaborations, but different approaches may be necessary among distant institutions (where regular in-person meetings are impractical) or among institutions with different missions and status.

In contrast to these circumstances, other key elements were incorporated by design, as listed in Table 2. First, the partnerships were discipline based, cross-institution, and faculty driven. Second, an agenda emphasizing curriculum and pedagogy across institutions (i.e., ALPS, Tutorials, LA programs) provided a concrete focus and helped make assumptions explicit through discussion with external partners. Third, intentionally valuing diverse faculty expertise supported equitable participation and a heterarchical partnership. Adding voices to the discussion, especially from smaller departments and different types of institutions, can provide the diverse perspectives and ideas needed to address complex issues in higher education. Further, including change agents at these institutions provides supportive expertise, encouragement, and credibility. Fourth, in both cases

external funding provided structure and time and raised the profiles of individual faculty, institutions, and the partnership itself. As a result, faculty from institutions with greater contact hours, and lower incentives and time to pursue scholarship, began participating in the national dialogue on science education. Finally, the LA model, which builds on the experience and expertise of students and faculty, played a role in both projects and provided a structure for both faculty change (as faculty redesign classes) and institutional change (as programs and institutions adopted the model in multiple classes and it became part of the instructional culture). Although LA programs were a common element in both projects, we believe that a number of research-based instructional models can create structure for the development and evolution of faculty identity.

We encourage those seeking to create effective, collaborative partnerships across institutions to identify partners based on the circumstances and core features discussed in this article that support the pursuit of shared goals. Once identified, prospective partners should engage in intentional activities to support the partnership through a focused agenda, funding, and implementation of research-based instructional models. In particular, we encourage the development of “heterarchical” partnerships that value and utilize the expertise of all participants regardless of institutional status. Emphasizing faculty development in such partnerships—rather than specific, prescriptive curricular or programmatic changes—can powerfully engage faculty in a process of reflective growth leading to increased initiative, ownership, and expertise. Such outcomes are essential ingredients for sustained change, but also entail extended timelines, unpredictable outcomes, and assessment challenges. We encourage policy makers, funders, academic

leaders, professional developers, and researchers to take these factors into account by supporting such efforts and developing assessments and metrics to evaluate them. ■

Note: In this article, we use *partnership* to refer broadly to activities undertaken by and relationships between TYCs and four-year institutions.

Acknowledgments

Authors CJD and EP thank Chandra Turpen for collecting interview data, Debbie DeRoma for coordinating the ALPS and LA programs in the San Marcos partnership, and Dan Sourbeer and the Palomar faculty for their participation. Authors AVD and MSS give special thanks to Anthony Escudero, Jaime Millan, Joshua Oladipo, and David Zoller, TYC faculty who have been collaborators with us on a number of education reform efforts. Angie Little, Shirley M. Malcom, Joi Walker, and Joel Corbo provided valuable comments on an earlier draft. This work has been supported in part by the NSF DUE-1068477, NSF DUE-1524829, the Department of Education-PBI, and the American Physical Society Physics Teacher Education Colation (PhysTEC).

References

- Cochran, G. L., Duzor, A. G. V., Sabella, M. S., & Geiss, B. (2016, July). Engaging in self-study to support collaboration between two-year colleges and universities. In D. L. Jones, L. Ding, & A. Traxler (Eds.), *2016 Physics Education Research Conference Proceedings*, pp. 76–79. Paper presented at the Physics Education Research Conference 2016, Sacramento, CA.
- Corbo, J. C., Reinholz, D. L., Dancy, M. H., Deetz, S., & Finkelstein, N. (2016). Framework for transforming departmental culture to support educational innovation. *Physical Review Physics Education Research*, 12, 010113.
- Cox, M. D. (2004). Introduction to faculty learning communities. *New Directions for Teaching and Learning*, 97, 5–23.
- De Leone, C. J., Price, E., DeRoma, D., Turpen, C., & Sourbeer, D. (2016, July). Successful STEM student pathways: A two- and four-year partnership. In D. L. Jones, L. Ding, & A. Traxler (Eds.), *2016 Physics Education Research Conference Proceedings*, pp. 96–99. Paper presented at the Physics Education Research Conference 2016, Sacramento, CA.
- Glesne, C. (2015). *Becoming qualitative researchers: An introduction* (5th ed.). Boston, MA: Pearson.
- Henderson, C., Finkelstein, N., & Beach, A. (2010). Beyond dissemination in college science teaching: An introduction to four core change strategies. *Journal of College Science Teaching*, 39(5), 18–25.
- Hirst, R. A., Bolduc, G., Liotta, L., & Packard, B. W. (2014). Cultivating the STEM transfer pathway and capacity for research: A partnership between a community college and a 4-year college. *Journal of College Science Teaching*, 43(4), 12–17.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.
- National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. Washington, DC: National Academies Press.
- National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2016). *Barriers and opportunities for 2-year and 4-year STEM degrees: Systemic change to support students' diverse pathways*. Washington, DC: National Academies Press.
- Nguyen, T., Lundy-Wagner, V., Samayoa, A., & Gasman, M. (2015). *On their own terms: Two-year minority serving institutions*. Philadelphia, PA: Penn Center for Minority Serving Institutions. Retrieved from http://repository.upenn.edu/gse_pubs/342
- Otero, V., Finkelstein, N., McCray, R., & Pollock, S. (2006). Professional development: Who is responsible for preparing science teachers? *Science*, 313, 445–446.
- Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics*, 78, 1218–1224.
- Phelps, L. A., & Prevost, A. (2012). Community college–research university collaboration: Emerging student research and transfer partnerships. *New Directions for Community Colleges*, 2012(157).
- President's Council of Advisors on Science and Technology (PCAST). (2012). *Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics*. Washington, DC: White House. (ERIC Document Reproduction Service No. ED541511)
- Sabella, M. S. (2002, August). Implementing tutorials in introductory physics at an inner-city university in Chicago. In S. Franklin, K. Cummings, & J. Marx (Eds.), *2002 Physics Education Research Conference Proceedings*. Paper presented at the 2002 Physics Education Research Conference, Boise, ID.

Charles J. De Leone is a professor of physics and associate director of the Center for Research and Engagement in STEM Education, and **Edward Price** (eprice@csusm.edu) is a professor of physics and the director of the Center for Research and Engagement in STEM Education, both at California State University San Marcos. **Mel S. Sabella** is a professor of physics and **Andrea G. Van Duzor** is a professor of chemistry, both at Chicago State University where they are co-directors of the CSU Learning Assistant program. Additionally, Mel S. Sabella is president of the American Association of Physics Teachers.
