**External Evaluation of The Leadership Collaborative (TLC)**

An NSF-funded Project by the

Association of Public and Land-grant Universities (APLU)

# FINAL GRANT EVALUATION REPORT

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# Case Studies of Four Institutions' APLU-supported Advancements in STEM Education and Teacher Preparation

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# Case Studies of Four Institutions' APLU-supported Advancements in Science and Mathematics Teacher Preparation

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**Document Description.** This document is a final report on data from the external evaluation of The Leadership Collaborative (TLC). The TLC was a project during 2008-2012 by the Association of Public and Land-grant Universities (APLU) and 25 member universities and colleges. Institutions pursued advances in their education of prospective middle and high school teachers in the subjects of science or mathematics. The project was funded by a National Science Foundation grant from NSF's Mathematics-Science Partnership program, Research, Evaluation and Technical Assistance projects (MSP-RETA): "Promoting Institutional Change to Strengthen Science Teacher Preparation", grant #0831950.

This report describes conclusions by contractor WestEd, independent of any views by the APLU; it does not reflect views or endorsement by NSF. The document has two parts:

(1) a brief over-arching synthesis of findings from the evaluation over the course of the entire project (eight pages); and

(2) case studies conducted of four institutions' APLU-influenced and -supported advancements in science and mathematics education and teacher preparation (approximately 10-pages each).

**Acknowledgements.** The external evaluation was initially designed and overseen throughout by Dr. Martin Orland, Director of WestEd's Evaluation Research Program (ERP). Orland also led evaluation of the project's critical convening of provosts in project year two and contributed to one of the case studies. Several evaluation tasks in year one were carried out by Dr. Joe McCrary, Senior Evaluator in WestEd's ERP Program.

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## Background

### The APLU Project and Its External Evaluation

The APLU prompted and aided 25 volunteer but screened member institutions in enhancing their STEM teacher preparation efforts, in both quantity and quality. All institutions had some prior projects underway to enhance STEM teacher preparation, or even many of them. However, this project's theory of effecting greater local change uniquely emphasized enlisting senior campus administrators (usually provosts) as change agents. [1] The APLU project engaged provosts particularly by holding one national meeting expressly designed for provosts and their accompanying local team leaders.

The project also held annual and other national project meetings for local team leaders; these meetings often also included other participants from their campuses. One of the grant PIs created an analytical framework (AF) that each institution used to comprehensively map its potential goals and strategies for enhancing STEM teacher preparation, from recruiting prospective teachers to improving teacher induction and professional development for their graduates. [2]

Therefore, the overarching foci of the grant's external evaluation by WestEd were determining:

(a) any **value-added role by APLU** to the institutions' existing efforts;

(b) whether provosts became engaged and the **effects of provosts' roles**:

(c) any effects of the Analytical Framework (AF) on Members' efforts.

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[1] Most NSF grants to IHE's for effecting changes in STEM education or teacher preparation do require central campus authorization or oversight of efforts; however, the grants are proposed by particular colleges or departments. In contrast, the APLU project required member applicants to craft campus-wide, institutional change efforts to be actively catalyzed by provosts and other central campus administrators and involve as many as possible relevant colleges and departments.

[2] The APLU project is further described in prior grant reports or the overall final NSF grant report by APLU, to which this final WestEd evaluation report contributes.

### Evaluation Data Sources

In earlier stages of the project, the external evaluation emphasized formative evaluation foci on investigating participants' feedback on project events (event evaluations) and APLU communications and service to participants.

Y1 Event evaluations - participant surveys and/or WestEd observation:

PhysTEC meeting (subset of institutions)

first TLC annual meeting

one-day meeting about Analytical Framework (subset of institutions)

Y1 Start-up interviews with team leaders

Y2 Event evaluation - participant surveys:

meeting for provosts and their team leaders

Y2 Formative evaluation interviews with team leaders

Later data collection emphasized summative investigation of the effects of APLU project activities:

Y3 Summative evaluation interviews with team leaders

Y4 Summative case studies of four exemplar institutions

## Results

Formative data indicated that, overall, participants valued **all** of the project's core events and activities: annual meetings for team leaders; the one-time meeting for provosts; the project staff's communications and organization; and the Analytical Framework.

Summative data from the Year 3 team leader interviews and site visits to four campuses indicated that:

1. Participants highly valued project meetings.

2. Institutions universally felt that having the imprimatur of APLU catalyzed whatever existing efforts had been underway.

3. For most campuses, use of the Analytical Framework prompted some new ideas about changing STEM teacher preparation, particularly for recruitment (efforts to recruit students into teacher preparation paths/programs).

4. About two-thirds of the institutions had active, unprecedented involvement from provosts, which led to more and/or different than usual efforts.

5. A prevalent change was the ability of provosts to leverage broader participation across colleges and departments, particularly crossing the sometimes challenging boundaries between education colleges/departments and those housing the STEM disciplines.

### *1. Participants Highly Valued Meetings (PhysTEC, Provost, Regular Annual)*

**PhysTEC meeting.** Prompted in part by the APLU project, 17 of the 25 institutions sent one or more representatives to a PhysTEC meeting in Pittsburg, organized by another project rather than the APLU grant. On a scale of 1 (lowest) to 5 (highest), participants provided high average ratings of most sessions (between 3.8 and 4.5); only one or two participants assigned the lowest ratings of 1 or 2 to any regular session. Participants particularly valued learning about the Learning Assistants (LA) program, highlighted by the University of Colorado-Boulder, and the UTeach program. In fact, the exposure of these programs at this event spurred many institutions to use/adapt the LA program in their APLU project plans, and accelerated plans by some institutions to explore becoming UTeach replication sites.

**Provost meeting.** Both provosts and their accompanying APLU-project team leaders highly valued the one-time meeting that APLU designed expressly for provosts. While APLU had solicited attendance by provosts at regular annual projects meetings, almost no provosts had previously elected to come. Given that fact and in light of the broad and extensive responsibilities of provosts at their campuses, it is remarkable that APLU was able to secure attendance for the special meeting by provosts from 60% of the project institutions. All attending provosts and 83% of team leaders completed surveys anonymously after the event. Provosts indicated the following:

All but two provosts agreed or strongly agreed with the questionnaire statement "the conference was sufficiently valuable to warrant my time."

Over 80% of provosts agreed with the statement "I am more likely to take an active role in effecting institutional changes (in STEM teacher preparation, and/or research about it)."

They particularly valued sessions about leading a process of change, and identifying promising practices for changing the institutional culture about STEM teacher preparation.

All but two provosts agreed with the statement "I gained ideas that I otherwise was unlikely to acquire in the near future for making changes at my institution."

**Regular Annual Meetings.** Based on annual phone interviews with team leaders from every institution, we report that, without exception, the team leaders generally found the regular project meetings to be useful. Interviewees often related examples of learning new specific ideas, projects or programs from the agenda, or from networking with participants from other institutions.

In addition to benefitting from the agenda and networking opportunities, participants from the same institution felt have having protected time together strongly advanced their local project work, for example[3]:

[3] Some provosts and their team leaders emphasized the same point about their time together during the special provost meeting, discussed above.

"It was very much for our institution a working meeting, where we could take back what we had accomplished at the meeting and begin working towards the implementation of those objectives. We were away from the university, we were away from other items that required our attention, and it was really useful for us. And it's difficult for everyone, I think, to find two or three days in common to dedicate to a project, and we appreciated that."

### 2. *APLU Imprimatur and Activities Provided Added Value to Local Efforts*

All but a couple of team leaders reported specific ways that participating in the APLU project brought added value to their local efforts, from modest leveraging/catalyst functions to more extensive and more substantive. In the more conservative cases, having the national spotlight of being part of the APLU project caused presidents or provosts to endorse and give authority to those who were already effecting enhancements in STEM teacher preparation, but they took few additional leadership actions. Nevertheless, having this heightened visibility/status on campus empowered these few individuals to further strengthen their efforts.

"I've been talking about this and doing it to an extent for years. I could never get the time, the financial resources, the staffing resources to take that idea further. But now, when I walk into [provost office] and say, 'Yeah, now, as part of the APLU thing we're working on', then [provost] sits up and says, 'What do you need?' This would not happen without the APLU relationship."

A great majority of team leaders saw greater institutional benefit (beyond their own efforts) from having the facilitation, catalyst, and imprimatur of the APLU for their local efforts, as illustrated by these statements:

"But I think that the fact that APLU focused attention on that gave us a point where we kind of focused some of that energy, because you had kind of a program and a process and a commitment, and so I think that opportunity was right for our institution. We had many pieces in place, but the APLU opportunity I think gave us a catalyst to move forward…So, I think it kind of stimulated a renewal of attention."

> "Part of the magic of this process is that having that an outside partner that's a little bigger, a little more weight and having a bully pulpit, I guess, of change and reform is very helpful to us."

### *3. Using Comprehensive Analytical Framework Identified Gaps, Connections*

The great majority of institutions found it useful to comprehensively map everything relevant to STEM education and teacher preparation, as illustrated below:

> "I think the articulation by APLU has been helpful. They've articulated [through the Analytical Framework] so many pieces of the pie, and that has put some things on the radar for me to think about and watch for internally that it would have taken me longer to pick up on. It's not that I wouldn't have noticed those things, probably, or worried about them or thought about what we're doing about them. But the occasion about being asked what we're doing about them has prompted me to have more sensitive radar for the range of issues associated with the endeavor."

As illustrated by the following comment, participants at many institutions were surprised to discover that there were existing efforts of which they were unaware:

> "I think what is really working is the attention that the [university administrators] have gotten about what's going on at their own university from the project, and the analytical framework in particular."

Institutions successfully used the AF to identify and prioritize one or more of three kinds of new goals: (1) identifying existing efforts that they wished to strengthen, (2) discovering latent connections between programmatic/project efforts across campus that could be marshaled for a synergy between them; or (3) discovering gaps or under-treated aspects of STEM education and teacher preparation that they wished to begin addressing more earnestly, or for the first time. The most common new pursuit was strengthening recruitment of students into teacher preparation paths or programs.

### *4. Engaged Provosts Leveraged Noteworthy Changes*

At the two-thirds of institutions where provosts or other central campus administrators became more than nominally engaged, team leaders saw this as important and influential for the advancement of the local project's efforts:

> "The first benefit, of course, at the institutional level is that it then brings in the involvement of the provost and president in terms of their awareness, their interest in the SMTI. And because of that level of involvement there's been a pretty wide distribution of support and of information about the program at the institution."

The four WestEd case studies included in this final grant report also provide clear, examples of strong actions by provosts, for example:

- personally co-leading the local project and participating in some meetings;
- fostering recognition of STEM faculty attention to education as being relevant in promotion applications;
- personally enlisting relevant faculty and administrators that had not previously worked together;
- providing team leaders with notable access to them and being responsive to requests; and
- providing high-leverage resources[4] such as providing space, funding outside speakers from another APLU project institution, and protecting critical faculty lines or degree programs in the face of overall cuts due to recent state financial crises.

### *5. Wider Campus Participation Across Common Institutional Barriers*

At some campuses, the APLU project's empowerment was limited mostly to those who already were engaging in advancing STEM teacher preparation. At many other campuses, the project drew in a wider set of players -- sometimes many more:

> "It's brought together a set of faculty that wouldn't otherwise have got together. We have different projects where we work with physics faculty, or biology faculty, or whatever, and it did create that umbrella to bring all of those people to the table at the same time. That was useful."

[4] modest but strategic dollars that catalyzed events or actions that were quite influential to the change process

> "I see more involvement with faculty in liberal arts, in particular with people in the [science] department. They actually have been involved in things which are the first time that I have seen them step up and be actively involved in the project other than just talking about what they already were doing."

It was particularly interesting that the project on many campuses was able to broach the historically common barrier that can exist between faculty in education and the STEM disciplines, as illustrated below:

> "For us, one of the biggest advantages to doing it was it was the first time that it really brought education faculty and science and math faculty in the room together to talk about the program."

## Appropriate APLU Attention to the External Evaluation

Finally, we note that APLU project staff actively considered the external, formative evaluation data from WestEd, and made project adjustments to ameliorate issues raised by participants or to enhance some project functions.[5]

- Some participants in Year 1 had raised concerns about the project's almost sole focus at the outset on teacher preparation in physics; the APLU staff diversified the project at subsequent events to include additional foci on other sciences and mathematics.
- When Year 1 evaluation data indicated that provosts were not engaging in the project as desired, APLU adjusted the project plan and budget to create a Year 2 meeting expressly for provosts and their accompanying team leaders.
- Project leaders made modest changes in the agenda and facilitation of later meetings to foster more inclusiveness of participants regardless of whether they were based in STEM disciplines or education; this was a response to concerns by the latter in Year 1 that a perception sometimes existed of affording them lesser roles/status in project activities or staff communications.
- As requested by team leaders during evaluation interviews, the APLU staff at some effort

[5] Project staff members' direct interactions with participants also led them to consider these changes. However, project leaders also deliberated over evaluation reports in a way that did result in 'data-driven decision making'.

created information displays and files that would aid participants from one institution to glean ideas from another.[6] As a second strategy for fostering cross-institution collaboration, the APLU established voluntary working groups on specific topics related to advancing STEM teacher preparation, which had been selected by participants during an annual project meeting. Half of the institutions had a faculty member volunteer to participate in these working groups.

[6] Surprisingly, later interviews indicated that only two team leaders related making any use of this information after receiving it. For those interviewees offering an explanation, the common view was that while everyone embraces the idea of learning from another institution, they find it hard to consider how to adapt the ideas from another institution's context for their local use.

# APLU Analytic Framework Propels Right-Hand Left-Hand to Collaborate:

# Enhanced Research on College STEM Instruction, and More Paths for STEM Teachers

## This document is a brief description of notable 2009-2012 changes in STEM education at **California State University – Fullerton campus (CSUF)**.

The described changes were prompted in part by this campus's participation in an NSF-funded project of the Association for Land Grant and Public Universities (APLU). The APLU grant's external evaluator, Ted Britton of WestEd's Program for Science, Technology, Engineering and Mathematics (STEM), created this brief case study. It is based on evaluation data acquired during the project, but particularly from a two-day site visit in March 2012 by Britton and Marty Orland, director of WestEd's Program for Evaluation Research.

### Case Overview

Several APLU project activities catalyzed changes at CSUF, including a conference for provosts and a site visit by project leaders to get detailed feedback by faculty from across the campus on the APLU Analytical Framework (AF). The AF prompts participants to map explicitly the institution's efforts to enhance any/all aspects of STEM teacher preparation - from stronger recruitment of students into teaching paths to ways of institutionalizing campus initiatives.

The case emphasizes two major changes in STEM education at CSUF that were particularly influenced by APLU activities:

1. The creation of the Catalyst Center, which aids faculty in both STEM and education departments to collaborate on increasing the amount and quality of research in STEM discipline education and STEM teacher preparation; and
2. The development of new student paths/options for STEM teacher preparation and ways of recruiting diverse student populations into all STEM teacher preparation programs.

Both of these efforts were in part spurred by campus leaders, consistent with another of the APLU project's overarching strategies - promoting institution-level changes by engaging participation of senior campus administrators, i.e., provosts and other central campus administrators, and deans of

relevant colleges. The case also illustrates how the APLU project influenced stronger cross-college collaboration and promotion and reward for a couple of participating faculty.

## Institutional Context

The Fullerton campus of the California State University system is located in the greater Los Angeles area (Orange Country) and in Fall 2011 served more than 36,000 diverse students who were Hispanic (32%), White (30%), Asian and Pacific Islander (22%), and Black (3%); remaining students (13%) were Native American, international, multi-race, or of unknown ethnicity. The university is rated 9th nationally by the U.S. Department of Education in numbers of degrees awarded to minorities, and 5th for Hispanic students. Therefore, CSUF success in doubling the number of STEM teacher graduates in recent years suggests the validity/viability of its institutional strategies as being effective with students of widely varying cultures and languages.

### STEM departments push for improved STEM course instruction through specialists, scholarship, and supplemental instruction

The university seeks to increase production not only of STEM teachers but of STEM graduates overall; enhancing instruction in STEM courses is seen as a key strategy to accomplishing this. Toward that end, the Vice President for Academic Affairs (VPAA, the CSUF provost equivalent), who also is the former Dean of the College of Natural Sciences and Mathematics (CNSM), has supported and increasingly urged STEM disciplinary departments to hire scientists and mathematicians who also have formal expertise and/or interest in enhancing STEM instruction; many CNSM departments now have from one to several such faculty members. The university also has set clear, written tenure and promotion guidelines that sanction scholarship in STEM education for these positions.

A second strategy for improving STEM disciplinary instruction is studying it through the auspices and means of a new cross-college center for scholarship in STEM education research, which was strengthened in part due to participation in the APLU project; this case study will describe the center.

A third strategy, also spurred further in part by the APLU project, is development of supplemental instruction (SI) opportunities for students enrolled in STEM courses such as calculus, which often can be gatekeeper courses that prompt students to leave their STEM majors. The University of Colorado-Boulder program of Learning Assistants in STEM courses was strongly highlighted at early APLU project meetings. The CSUF campus already was exploring SI in the context of their participation in a National Science Foundation grant program that pursues more successful retention of STEM majors (the NSF STEP Program). Therefore, CSUF participants' disposition toward SI strategies was reinforced by the APLU meeting agenda and the UCB model. Subsequently, the CSUF campus adapted a similar SI model developed by the University of Missouri, Kansas City, to support student learning in several STEM courses at CSUF.

### A high priority of the state university system

Prior to the APLU project, the CSU and University of California statewide systems had in place a major initiative to increase the number of STEM teachers produced in California. For this reason and others, over a dozen major campus initiatives already were underway at CSUF to enhance STEM education and STEM teacher preparation, many of them supported by competitively obtained, external grants. Therefore, in general, neither CSUF nor APLU claims that the APLU project was responsible for the genesis of CSUF initiatives; however, participation in the APLU project did strengthen CSUF activities.

However, applying for and being accepted into the APLU-TLC national collaborative of 25 institutions also brought the Fullerton campus acclaim from the CSU system and increased structural supports from the system for local efforts, such as: being showcased by the CSU system Chancellor at high-profile public events; expedited approvals for course or program changes; and some preserved budgets in the face of a general reduction of system funds available because of severe state budgetary shortfalls.

Such local recognition and support in turn further increased CSUF participants' commitment and responsiveness to the APLU project. The CSUF participants also capitalized on the imprimatur that APLU project membership could command; "I can't tell you how many times we've used the APLU TLC project participation to argue our capacity in reports or proposals." [Dean, College of Education]

## Analytical Framework Analysis Propels Cross-College and –Department Collaboration

The APLU project leaders developed an Analytic Framework that can prompt and empower campus participants to comprehensively map goals for enhancing efforts to improve STEM teacher preparation or to create new ones. The AF and project activities about it strongly influenced CSUF efforts.

### A Framework spanning all aspects of teacher 'preparation'

The Framework comprehensively captures the STEM teacher education enterprise in five goal areas: recruitment of diverse students into teacher preparation; improving the quantity and quality of teacher preparation; addressing teacher induction for graduates and others; addressing professional development of graduates and others; and making institutional changes to effect and sustain these changes. Each goal area includes several specific strategies for addressing the goals.

### A visit by APLU project leaders prompts more systemic action

As a requirement of participation in grant year one, APLU asked every institution to set strategies for one or more of the five AF goal areas. The CSUF plan focused most strongly on three goals: strengthening recruitment, enhancing teacher preparation, and promoting institutionalization of changes. Only a few key players developed the plan that CSUF submitted at this stage in the project. As a result, this early planning mostly led to more thorough documentation of existing efforts by those in the know rather than catalyzing new initiatives or wider buy-in. The analysis did

bring a few overlooked, systemic gaps back onto the institution's radar; for example, the physics department reinstituted a physics course when education faculty discovered that its absence in recent years was a gap in the path for prospective physics teachers.

In grant year two, however, APLU project director Jennifer Presley as well as the grant co-PI and lead developer of the AF (Charles Coble) visited CSUF and some other campuses. The ostensible purpose was to get feedback on the AF tool for its further development, but project leaders also sought to prompt more detailed institutional examination of teacher education enhancements by a wider range of campus stakeholders.

This APLU one-day, onsite consultation was a milestone event for advancing CSUF efforts. During the field visit for the current evaluation case study, a range of interviewees described the value of this earlier event:

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"I remember this meeting very well. It provided an opportunity for faculty to get together and see what's happening at different parts of the college and university. I think some subsequent collaborations are an outgrowth of that. And now, sometimes when you are at team meetings for an initiative, you would never know they are from different colleges; it's amazing." [Dean, College of Education]

"They were excited to meet and map everything out, and to see how everything fit together. I used to describe what each person was doing. Now people's fingers are in many pies." [APLU project coordinator at CSUF]

"There were lots of programs and revisions already going on here for STEM teacher preparation, but the APLU project ensured that key folks had quality time to work together on them, and across them." [VPAA (provost equivalent)]

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Since the APLU visit, CSUF not only has populated teams that are focused on initiatives with cross-college or –department representation but also is planning to experiment with additional mechanisms for continuing functional knowledge exchanges across institutional boundaries: a newsletter, a yearly retreat or symposium, and creation and better institutional circulation of program descriptions and data. Exchanges also occur during meetings of the new Catalyst Center, described below.

## A Center for Increasing Scholarship in STEM Education

During the APLU project years and aided by project activities, CSUF strengthened a new cross-college *Catalyst Center for Research in Science and Math Education*. CSUF campus leaders established the Center to address local needs for strengthening scholarship in such research. APLU project activities helped prompt them to accelerate the Center's development and the cross-institutional reach of its activities.

### A need to strengthen scholarship in research in STEM education

The Center was formed in part to focus research on improving STEM course instruction, by acquainting STEM disciplinary researchers of research-based ways of improving their instruction. Both STEM department disciplinary faculty and educational specialists residing in the STEM departments also needed support to increase research on CSUF STEM education. Campus leaders reported that the applicant pool for education specialist positions in STEM departments has fewer applicants compared to those who pursue posts for further STEM disciplinary research; while the latter commands applicants who have matriculated their doctorate and usually also have post doctoral STEM research experience, the disciplinary-trained education specialists often have not completed their dissertations prior to CSUF hiring decisions or sometimes prior to their job start; therefore, they often have not yet conducted much education research, and/or research that has formal study designs and execution. As a result, the university sought ways to increase scholarship on STEM teaching and learning.

### APLU project activities influenced enhanced campus commitment to Catalyst Center, and other STEM education enhancement efforts.

University leaders funded a limited, early version of the Center. They subsequently worked with the area's U.S. Congressional representative to secure additional, external funding.

During the second year of the APLU project (2010), APLU project leaders convened a two-day, one-time meeting expressly for provosts of the 25 project institutions, each accompanied by their campus coordinator/representative to the APLU project. The CSUF VPAA at that time (who was succeeded in later years of the APLU project period by the then CNSM dean) is one of the 60% of provosts in the project who agreed to attend this APLU experimental meeting, i.e., a convening of its client central campus leaders for a sustained, deep focus on specific educational issues in specific subject areas.[7]

This meeting was a short but high-leverage moment in the evolution of the APLU project at CSUF. The VPAA was influenced to act in two ways. The meeting agenda included a focus on promotion and retention issues that deter STEM disciplinary faculty from spending time on STEM education

[7] APLU meetings drawing such institutional leaders typically emphasize overarching institutional administrative and organizational issues rather than focusing on specific subject domains.

issues. This reinforced the VPAA's view that the Catalyst Center was an important university initiative. Secondly, the joint travel and attendance time afforded the VPAA and CSUF project coordinator to spend sustained, quality time in planning CSUF participation in the APLU project; on campus, it would be rare for even a senior faculty member (e.g., the APLU project coordinator) to have such sustained, substantial access to the VPAA.

As a result of these influences, the VPAA added more institutional funds to the Catalyst Center even though it already had external funding. These funds enabled released time that permitted the then-Center director, who also was the APLU project coordinator, to devote more attention to it.

### Enhancing scholarship in STEM education toward enhancing STEM instruction

An average of 8-10 and up to 15 participants from across the university meet monthly to do such things as:

- discuss published research in STEM education;
- design studies that can provide evidence of the effectiveness of STEM department instruction changes on campus (e.g., SI, supplemental instruction in gatekeeper STEM courses);
- discuss, critique and advise STEM education research underway on campus;
- share and provide constructive feedback on draft publications about research studies on campus; and
- collaborate on development of proposals for external funding that involve staffing across institutional boundaries.

Such discussions also have the important side benefit of keeping participants abreast of what's going on around campus and strengthening their relationships in working on other cross-unit STEM initiatives.

The Center's level of activity has increased over time, and in early 2012 the university assigned it a permanent physical space and two full-time post docs were hired to support its work; this enhanced staffing and facility enables the Center to offer such services to faculty as assistance in conducting literature reviews in STEM education to supporting STEM department faculty in their development of articles or proposals for funding in STEM education.

## Strengthening Cross-college and –Departmental Collaboration

The university credits the APLU project with prompting more and stronger cross-college and cross-department connections at CSUF:

> "Truly, the left hand didn't know what the right hand was doing. All these key people already were doing important things to enhance STEM teacher preparation, but they seldom knew what else was going on." [APLU project coordinator at CSUF]

The multiplied connections strengthened efforts already underway for enhancing STEM education and teacher preparation, and also resulted in some new initiatives.

### Catalyst Center strengthens connections

From the outset, the Center was a cross-college collaboration, funded by the Deans of Education and CNSM and was formally established through a Memorandum of Understanding between the colleges. The two deans on occasion still attend some meetings and for other meetings frequently have an associate dean represent them. Being signed up as an APLU project institution and having that visibility only reinforced their commitment to stay abreast of Center activities.

Center meetings afforded opportunities for STEM department faculty to more directly understand the kinds of expertise that Education faculty can bring to the table, and for Education faculty to better understand the disciplinary perspectives of CNSM department faculty. The STEM department faculty appreciate that the Center focus keeps an emphasis on strong disciplinary content knowledge while strengthening educational aspects, as illustrated by these remarks by the Dean of CNSM: "We haven't given up anything; we've gained collaboration with [the College of] Education." A small but illustrative new understanding was their joint realization of the following cultural difference between faculties in the two colleges:

> "The CNSM faculty were frustrated because they would call us or come by to see us and we wouldn't be there, and maybe even wondered about our work ethic. In their work life, they can be in the lab day and night on any day, and often for many days. They hadn't understood or absorbed that we are constantly out there doing research and providing services to schools, also for long hours, or appreciate how challenging that work is. And we wondered how serious they were about being interested in educational aspects of their STEM courses, which turned out to be quite high in some cases." [faculty member, College of Education]

At the beginning of the APLU project period, the Center director was the APLU project coordinator, an education faculty member who was given a joint appointment in CNSM to be

consistent with the Center's mission. A CNSM faculty member has more recently assumed the director duties, but the cross-college emphasis was strengthened further by formally adding two associate directors, one from CNSM and the other from Education.

### More Students in More Paths to STEM teaching

The push by the CSU system and additional leveraging of the high-national-profile APLU project to increase the numbers of STEM teachers spurred CSUF to use three strategies to increase STEM teacher output: (1) creation of additional paths to STEM teaching; (2) stronger recruitment of students into them; and (3) enhanced STEM course instruction to retain students as majors in STEM disciplines and STEM teacher preparation.[8]

The CSUF campus has a very wide array of paths to STEM teaching credentials and has obtained external sources of direct financial support to students who pursue some of them. The VPAA directly supported continued internal support of these teacher pathways, influenced in part by his participation in the APLU project's meeting for provosts, described previously. The meeting discussions reinforced the VPAA commitment to shelter funding for other STEM education initiatives in the face of severe California budget reductions to the CSU system.

He even authorized funding to launch a new initiative that was awaiting action – establishment of a new middle school math and science credential that would in part recruit more students from the nursing and health sciences college into teacher preparation paths. Also, a new BA program in earth science results in an earth science teaching credential focused on contemporary domains and issues of earth science relevant for teaching students in middle and high school.[9]

The APLU project strongly influenced more attention to recruitment. In using the comprehensive Analytic Framework for mapping all aspects of teacher preparation, many institutions in the APLU project were surprised to discover that they had paid inadequate, ad hoc attention to how prospective teacher education students could learn about opportunities relevant to them, and how program faculty could reach out to them. Faculty in teacher preparation naturally gravitate to exploring ways of enhancing their programs, but less often consider ways of more effectively recruiting students into them in the first place.

The CSUF faculty and administrators had the same realization during APLU project leaders' visit to engage campus-wide participants in using the AF. Subsequently, they created more kinds of information and ways of disseminating it. The evaluators visiting for this case study received dozens of brochures and information sheets describing teacher preparation options, often written in different ways about the same program to reach different kinds of audiences. Several faculty members also more strongly interacted with the university's Center for Careers in Teaching. Most students contacting the Center are exploring elementary-level teaching; STEM and Education

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[8] This third strategy was described previously, e.g., in describing the work of the Catalyst Center and creation of supplemental instruction opportunities (SI).

[9] It is a prevalent problem in U.S. K-12 science education that teachers of the earth sciences do not have much formal preparation beyond their own high school learning.

faculty worked with Center staff to better reach its client students with information about the new options for pursuing certifications for teaching science and mathematics at the middle school level.

## Influences on Faculty Promotion and Reward

Participation in APLU project activities by two CSUF faculty members contributed to their CSUF faculty reviews. During the first annual APLU project meeting, one of the faculty members networked for substantial amounts of time with faculty from other institutions who had similar projects and research interests. These conversations prompted the CSUF faculty member to more seriously consider whether she had adequate evidence of her CSUF project's success, and to devise research designs for obtaining stronger evidence. After implementing these ideas in her project and research, she published an article in a refereed journal. In an interview for this case study, she described that article as deciding factor to pursue promotion to full professor and a contributing factor in the successful review of her promotion application.

A second CSUF faculty member who also had attended the first APLU project meeting and networked with other participants joined an APLU project-sponsored effort in grant year three. APLU supported the establishment of several working groups of faculty representatives from across institutions who volunteered to hold focused discussions and review literature on key aspects of changing STEM teacher preparation. The CSUF faculty member's participation in one of these groups brought her some important recognition within her faculty review at CSUF.

# Establishing a Campus-wide Center for STEM Education, and Heightened Attention to Teacher Recruitment

## This document is a brief description of notable changes in science, technology, engineering, and mathematics (STEM) education and teacher preparation at South Dakota State University (SDSU).

The described changes were prompted in part by this campus's participation during 2009-2012 in an NSF-funded project of the Association of Land Grant and Public Universities (APLU).

This case study was conducted by the external evaluator for the APLU grant, Ted Britton, Associate Director of WestEd's Program for (STEM). It is based on evaluation data acquired during the project, but particularly from a two-day site visit in March 2012.

### Case Overview

It is notable that any strong advances in STEM education and teacher preparation occurred at SDSU during the APLU grant years because this campus was experiencing serious organizational turbulence, for example: substantial budget reductions; major consolidation of colleges and departments; turnover in three college dean positions relevant to teacher preparation; and the recent appointment of a new provost. However, there was a willingness despite this turbulence to continue advancing STEM education efforts because this was widely perceived among interviewees as "mission consistent" with these SDSU emphases: quality teaching and service to the state's K-12 education community; and growing leadership as a STEM research institution. The project also could build upon an existing cadre of faculty, drawn from across four different colleges, which was committed to the enhancement of STEM preparation.

This case focuses particularly on two elements of SDSU efforts to enhance STEM education and teacher preparation as part of the APLU project: (1) creation of a campus-wide STEM education center, and (2) a heightened emphasis on recruitment of more students into STEM teacher preparation.

This case only briefly describes the center's structure and activities because the launch of the center had just come to fruition toward the end of the APLU grant. The report instead elaborates the players and process involved in designing and planning the center, because there are some clear examples of evidence that national APLU project activities accelerated and strengthened the process, in particular:

- engaging the Provost Laurie Nichols, who in turn provided strong auspices and support actions for the development team; and

- making it possible for SDSU to identify an APLU team leader from another APLU project institution to facilitate a two-day colloquium, which widened campus participation and catalyzed subsequent engagement of external stakeholders.

Among the four cases in the APLU project's evaluation, this one provides some of the clearest evidence of the potential contribution and influence of active leadership from the central campus administration. The APLU organization's decision to hold a national project meeting expressly for provosts was crucial to gaining Dr. Nichol's participation. Among the 25 APLU project institutions, SDSU is an outlier in having assigned the local APLU project team leader role to an assistant professor. The effectiveness of Ken Emo in this role was enabled in part by the active engagement of the provost.

The second effort at SDSU that is emphasized in this case is heightened attention to stronger recruitment of students into STEM teacher preparation, both among undergraduate students on campus and by longer-range recruitment through outreach to high schools. The national APLU project's Analytic Framework tool prompted SDSU participants to realize that the national project's goal for participating institutions to increase STEM teacher production could be achieved in part by focusing more clearly on recruitment into teaching.

Finally, this report briefly notes how the regular, annual APLU national project meetings enhanced SDSU project execution. Because varied key faculty and administrators joined Dr. Emo at some APLU project meetings, with some cost defrayed by the APLU, the SDSU project team was able to better maintain focus and momentum on their local efforts in the face of organizational turbulence. Also, a physics faculty member was intrigued by the UC-Boulder Learning Assistants program, which was highlighted at an early APLU project meeting. He explored adaptations back at SDSU.

## Institutional Context

South Dakota State University, serving about 13,000 students, is the largest university in this rural state of about 840,000 people. The largest numbers of minority students at SDSU are Asian or Pacific Islanders and Native Americans, but with each comprising less than 3% of the study body. The institution produces more secondary teachers than any other college in the state; SDSU does not prepare elementary teachers, although it has the state's only early childhood education major program that includes certification of K-3 teachers.

Prospective STEM teachers obtain a bachelors degree in a STEM discipline and concurrently complete a 34-credit program in the College of Education and Human Sciences. A standing university-wide teacher education committee of STEM department heads, the dean of the education college and its department head for teacher education, and some relevant senior faculty from across the institution meets twice per semester to address issues in teacher preparation programs.

Within this programmatic structure, there is no institutional barrier for STEM departments to be supportive of students who wish to pursue teaching. That is, the STEM departments still maintain such students as majors, in contrast with other organizational structures wherein STEM departments could potentially 'lose' them to an education department or college. However, classic

potential biases could still exist among STEM department faculty against talented STEM students' pursuit of teaching instead of careers or further study in STEM.

### An institutionally "mission consistent" focus on STEM education

Multiple interviewees from across the institution indicated that there historically has been a culture of support for them to pay attention to STEM education and teacher preparation. The faculty feels strong ties to the state and its needs, leading to a "mission" for quality teaching that was widely espoused, from the provost to individual faculty.

The STEM departments of this R1 institution have had a reputable STEM research agenda that has grown in recent years to attract more external funds for research. However, many STEM faculty members are committed to not letting this increased research prowess inadvertently distract the institution from concurrently keeping a targeted focus on STEM education and teacher preparation. For example, the chemistry department chair reminds faculty of the following:

> "Competitive proposals to NSF increasingly require strong sections on Broader Impacts, which can be addressed through solid attention to how the proposed research project can impact STEM education and teacher preparation."

### Major college reorganizations and challenging budget reductions

Coordinating STEM teacher education at SDSU has always been challenging because STEM departments relevant to STEM teacher preparation are housed in three colleges, for example: the mathematics department (and formerly the physics department) is in Engineering; the biology department is in Agriculture and Biological Sciences; and Arts and Natural Sciences is home to the chemistry department. And the actual certification is offered through a fourth college, Education and Human Sciences.

Moreover, during the APLU project years, major college reorganizations and budget reductions occurred that increased the challenge of addressing STEM education and teacher preparation issues. Reorganizations involved changes in both organizational structure and leadership staffing. The education college merged with college for family and consumer sciences to become the College of Education and Human Sciences. Within the new combined Education and Human Sciences, eight former departments of education were reduced to four, resulting in a very large, reorganized department of teaching, learning and leadership. A variety of factors were prompting the potential merger of the physics department with another STEM department; instead, it was kept intact but re-housed within Arts and Science rather than its former home in Engineering.

Many leadership personnel changes also accentuated challenges for implementing the APLU project: the dean of a college merging with the education college was promoted into the university provost position; a new dean of education and human sciences was hired from the outside after

having an interim dean for two years; there was turnover in the dean position for Agriculture and Biological Sciences; and Arts and Sciences had an interim dean for a year.

Finally, the state has been affected in recent years by the nation's economic challenges and had to reduce SDSU funding. For example, faculty did not have raises or cost of living adjustments for three years, and deans and departments chairs have had to make significant, wide-ranging kinds of budget cuts.

## Empowering Bottom-Up Changes

Given the substantial organizational turbulence described above, how did the SDSU team successfully implement efforts to advance STEM education and teacher preparation? Their change model was continuing an existing cross-college cadre of committed faculty and external stakeholders but adding empowerment through strong provost involvement.

### Launched and monitored by central campus administrators

The university president personally signed SDSU onto the project when APLU canvassed members for their interest. When the APLU arranged a high-profile event with President Obama, it put a national spotlight on the 25 participating institutions; this, in turn, helped prompt continued attention to the APLU project by the SDSU president, who conveyed the importance of this initiative to the recently appointed provost. The current case will highlight how the provost's involvement was a key factor in the success of the described efforts.

### Empowering an existing cross-campus cadre of committed faculty

This initiative was able to advance because it could build upon and foster bottom-up efforts. A handful of faculty from across the campus has been dedicated to collaborating on advancing quality STEM teacher preparation. Examples of their efforts in years prior to the APLU project are: co-teaching the science methods course even though they come from different STEM departments; and providing professional development and technical assistance to STEM teachers in the state.

On top of such pre-existing collaborative efforts, during the first two summers of the APLU project, the cadre convened as often as weekly to flesh out priorities and plans for improving STEM teacher preparation efforts across SDSU. There were no tangible incentives to participate. On occasion, they even met with administrators as early as 7am in order to avoid scheduling conflicts that would prevent some members from attending at more typical meeting times. The participating APLU project team leader noted that, in addition to commitment and purpose, positive dynamics among the particular individuals in this cadre encouraged participation: "We didn't see this as an imposition; we enjoy working with each other."

### Involving external, K-12 education and state stakeholders

These faculty members arranged for stakeholder teachers from the area to join them every Wednesday for many weeks to discuss the goals and functions of a potential university center for STEM education. Having the APLU project imprimatur helped them to consider also attracting participation by legislators. A legislator worked with SDSU to explore ways to request funds for new

initiatives. Subsequently, some resulting legislative funding requests had to be run through the institution's channels at the level of deans and central campus offices; in turn, this helped maintain those administrators' attention to and support of the APLU project.

### Empowering an assistant professor to serve as team leader

The SDSU case is a rare instance when an assistant professor was asked to be the local team leader for the APLU project. This occurred in part because the previously described turbulence of staffing changes among senior administrators might have dampened their ability to give adequate attention to such a role, or limited the likelihood of a person having continuity in the role. Among the 25 institutions participating in the APLU project, the great majority solicited a dean, department chair, STEM center director or an associate or full professor to be the local APLU project team leader. The authority or status of such positions inherently enabled those team leaders to attract attention to their APLU project communications and influenced faculty to execute project requests.

Typically, it could be awkward at many institutions for a professor to send communications that include requests for attention or action from administrators and to expect fruitful responses, if not repercussions to the sender. However, the SDSU provost established at the outset that the professor was acting at her request and he was authorized to judiciously use her name and auspices in project communications. She also interacted directly with deans or chairs when required to aid the project in gaining the needed attention or actions. Administrators seemed comfortable with the project management and were responsive to its requests. From the provost-level perspective, however, this structure required more active engagement and level-of-effort from the provost on project administration than models wherein a senior campus leader was the project team leader.

## A Cross-College Center for STEM Education

The APLU project participants pursued creation of a university-wide center as a principal strategy for advancing STEM education and teacher preparation. As noted above, they met regularly to develop its particulars. They secured campus funding from the provost for a colloquium to brainstorm ideas for a center. The colloquium was held at a centrally located venue in a marquee, new campus facility.

For the colloquium, SDSU participants brought in a speaker from another university in the APLU project, which had an existing, exemplary P-20 STEM education center. The event attracted and engaged many stakeholders from across the campus as well outside stakeholders. On the second day, a range of SDSU participants held working meetings to outline ideas and plans for developing the center and other initiatives.

In the months after the colloquium, SDSU participants continued to develop plans until they had a formal proposal document. The two-day event also had prompted enough interest from the external stakeholders that they subsequently met with SDSU faculty often to plan ideas for the center and enhancements of STEM education outreach more generally.

Over a dozen SDSU participants met as a group on two occasions to present iterations of their center proposal to the provost. The provost reported that she was very impressed with the level of quality and detail of the proposal. She regarded the fact that the entire planning group was on hand

for the meetings with her to be a testament to their degree of initiative and buy-in to the endeavor.

The provost in turn offered strong organizational support for establishing the center, including providing limited funds at the center's outset in the face of an overall severe funding climate.

Nevertheless, in collaboration with the provost and Dean of Engineering, the mathematics department chair was able to provide material conditions and resources to launch the center, such as providing a newly remodeled office space and a small budget. He also provided release time for an interim director, a mathematics faculty member who focuses on issues in mathematics education. This professor is one of the initial cross-campus cadre of faculty that has been interested in advances for STEM education; she has the support of the rest of the cadre.

Now in its early stages, this new *Institute for STEM Education Enhancement (ISEE)* is sorting out its first steps within a wide range of desired goals and activities. Overall, its existence increases the likelihood for a synergy among existing programs and initiatives, and more centrally located knowledge that can be brought to bear in developing proposals for external funding. As for direct action, much of the Institute's efforts will assist strengthening the institution's long-standing outreach efforts in K-12 STEM education around the state; this is a crucial activity in a rural state where most science teachers have to teach more science subjects than the ones in which they have deep formal education.

### APLU Analytical Framework Strengthens Focus on Teacher Recruitment

Additionally, the first listed goal of the Institute – enhanced teacher recruitment - likely exists or became first on the list due in part to awareness created by the APLU project. The national APLU project leaders developed an Analytic Framework tool that can prompt and empower campus participants to comprehensively map goals for enhancing efforts to improve STEM teacher preparation, or to create new ones. In grant year one, APLU asked every institution to set strategies for one or more of five AF goal areas: recruitment, preparation, mentoring and induction, professional development; and policy, structures and processes that support improved science and mathematics teacher preparation.

In using the comprehensive Analytic Framework, many institutions in the APLU project were surprised to discover that they had paid inadequate, ad hoc attention to how prospective teacher education students could learn about opportunities for teaching, and how program faculty could reach out to them. Faculty in teacher preparation naturally gravitate to exploring ways of enhancing their programs, but less often consider ways of more effectively recruiting students into them.

Similarly, SDSU participants were surprised to discover opportunities to strengthen teacher recruitment and pleased to focus new energy on identifying and implementing strategies for doing so as part of the new center but also through a wider variety of means:

"[The APLU Analytic Framework] structured our conversation so that we came up with things that we might not have come up with anyway. We could work more closely with university relations and admissions, particularly admissions; hearing how an assistant dean in engineering does this to recruit engineering majors was something we wouldn't have thought of otherwise." [APLU project leader at SDSU]

The SDSU participants used two over-arching strategies for increasing teacher recruitment: (1) strengthening ways of getting information to undergraduates and actively soliciting their interest in a teacher preparation path; and (2) pursuing longer-range, earlier recruitment by outreach in high schools, including in schools having larger populations of Native Americans.

### Recruiting undergraduates

Participants identified and shared their existing activities and strategies for undergraduate recruitment and also tried some new ones, for example:

- The Department of Teaching, Learning and Leadership developed a professional, three-minute video that encourages undergraduates to considering teaching;
- an instructor for introductory chemistry courses explicitly prompts students to consider their interest in becoming a teacher;
- a biology major can elect to focus a required senior research project on biology education;
- a biology faculty member who teachers a course for non-majors also is invited into other biology courses to promote interest in biology teacher careers;
- a required course for introducing mathematics majors to potential career paths includes bringing in a faculty member who specializes in mathematics education, to prompt consideration of a mathematics teaching career; and
- a plan for working with the registrar to develop strategies for contacting relevant students as freshman with information about teacher preparation path options and how to obtain more information about them.

### Reaching high school students

As noted earlier, the SDSU faculty has a history of conducting professional development and other outreach activities to the state's K-12 schools. However, APLU project participation heightened faculty attention to making recruitment of high school students as prospective STEM teachers a more explicit, additional purpose of their work. Several interviewees raised this issue, including both a chemistry educator and a physics educator who for years have worked with tribal schools, the source of one of the two largest minority groups in the state's student population.

## Active Leveraging by Provost

Among the four conducted studies, this case best illustrates the feasibility and impact of provost leadership in advancing local implementation of the APLU project, and how APLU project activities

catalyzed the provost's engagement, particularly through a special two-day meeting that the APLU held expressly for provosts.

### Providing support and attracting project engagement

The provost took a wide range of actions to catalyze local project execution. As described previously, the provost provided the active support necessary to empower a faculty member to be effective in his role as local team leader for the APLU project. Other examples include:

- attending a special, two-day APLU project meeting for provosts, and working lunches for provosts in the project during annual APLU organizational meetings;
- providing a $12,000 internal grant to fund the two-day colloquium about establishing an SDSU center for STEM education and teacher preparation;
- showcasing a STEM faculty member's scholarship in science education in university communications;
- attending a few early meetings to launch the project;
- formally recognizing scholarship of teaching and learning for promotion and tenure in STEM departments;
- encouraging a new dean to attend the annual APLU project meeting even though it was scheduled only a couple of weeks after her arrival at SDSU;
- meeting with the APLU project team on more than one occasion to discuss formal proposals for establishing a STEM education center; and
- working with deans to preserve an independent physics department[10].

The active participation and leadership of the provost gained the attention of and subsequent actions by other campus administrators, as illustrated by these sample interview excerpts:

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[10] Preserving the physics department was an important action for science education in South Dakota; this action probably was influenced by participation in the APLU project. Losing the department could have diminished the university's ability to offer a physics teacher credential and and/or its ability to provide professional development and outreach to K-12 teachers. The campus has one of only two programs in the state for preparing credentialed physics teachers; while SDSU historically has only produced up to a couple of physics teachers per year, the other institution has not produced any physics teacher in most recent years. Also, because many science teachers in rural schools must teach physics even through they have little or even no formal education in physics, they value the university's ability to provide in-service professional development about physics teaching. The APLU national project strongly highlighted attention on the shortage of physics teachers; this emphasis likely contributed to SDSU decisions to maintain the department.

"It impresses me that the [local APLU project] is under the provost's purview!" "I noticed the provost played a role in the launch of this project and that encouraged my attention." [two senior campus administrators]

"Having the provost support a university-level policy of sanctioning education scholarship in STEM disciplines helps avoid complications from faculty committees when a faculty member includes this in a promotion request." [a STEM department head]

Several respondents felt that without the provost's attention, it is unlikely that SDSU would have been able to effectively implement new or heightened STEM education and teacher preparation activities in the face of major institutional challenges in progress at the same time. In short, the APLU imprimatur and project activities helped prompt university leadership to provide impetus, gravitas, and conditions for local implementation.

### APLU engagement of provosts through regular and special project meetings

Interviewees noted how influential the national APLU project meetings were in gaining and sustaining the provost's engagement. During the standing, annual APLU association-level meetings, invitational working luncheons were held for provosts from the 25 institutions in the STEM education and teacher preparation project.

Further, during grant year two, the APLU decided to convene a special, two-day meeting for provosts in the project, accompanied by their designated local APLU project team leader. Provosts from 60% of institutions attended, including the SDSU provost and team leader.

The provost luncheons and particularly the special two-day meeting were pivotal in gaining the engagement of the SDSU provost, as indicated below:

"I know that meeting was a critical point in getting her support. She has referred back to the Miami meeting on occasion and in a public way, when speaking with deans and department chairs about our project efforts here." [local APLU project team leader]

From the provost's perspective, convening provosts as a peer group helped validate provost-level involvement in the project. Further, having the joint travel time and sustained time during the meeting helped the provost and team leader to advance ideas for working together on the project. Finally, this 'protected' time also enabled each of them to pause and reflect at length on ideas and plans for implementation back home, as illustrated below:

> "I still sometimes refer back to my notes from that meeting. The most influential sessions for me were about institutional change. They reinforced my focus on seeing my role as change agent rather than being limited to administrator. The meeting gave me the opportunity of time to stop, evaluate where we were, and reflect on what we might do. Also, we previously hadn't thought of recruitment this much." [Provost]

## APLU Regular Project Meetings Spurred Campus-wide Engagement and Follow-up, Cross-Institutional Exchanges

Each year, the APLU held a project meeting for team leaders from the 25 participating institutions; in several years, the APLU also invited institutions to send additional participants.[11] Jointly attending these annual meetings sustained project focus and interactions among participants from across the SDSU campus. Meeting participation also resulted in gaining specific ideas and assistance from other institutions for SDSU implementation.

### Maintaining involvement of SDSU administrators

The provost and team leader at SDSU took advantage of the APLU offer to bring additional project participants to the annual meetings, as well as the APLU offer of funds to help defray the travel costs involved. Over the years, several faculty joined the team leader at meetings. Further, some administrators also came -- the newly arrived external-hire Dean of the College of Education and Human Sciences, and the chair of the new Department of Teaching, Learning and Leadership. Such administrator participation helped sustain project momentum in the face of the turbulent SDSU reorganizations and personnel changes in senior administrator positions.

[11] Provosts did not attend these project meetings unless they were serving as the local APLU team leader.

### Catalysis of learning about Learning Assistants at UC-Boulder

A physics faculty member attending an early national APLU project meeting at UC-Boulder became very interested in that institution's robust Learning Assistants program, which was featured in the meeting agenda. He and several SDSU interviewees mentioned the model's potential and were experimenting with a local adaptation. Several SDSU project participants envision the program as aiding student learning in physics but also, as an explicit side benefit, potentially recruiting more physics majors into teacher preparation.

### Bringing another institution's APLU project leader to campus

A key step in development of the center was a previously described, two-day colloquium, which engaged wider campus and external stakeholder interest by promoting brainstorming of possible center models and strategies. Many interviewees gave unsolicited descriptions of this event as an influential contribution to the process. They viewed the event as a success in part because it featured Associate Provost John Yopp's description of the mission, strategies and success of the P-20 STEM education center at the University of Kentucky, another participant in the APLU project.

The SDSU provost felt that Yopp provided "valuable ideas" and found the success of U. Kentucky's program in tackling an ambitious agenda to be "inspirational". This influential moment in development of the SDSU plans likely would not have occurred the same way without the APLU project. The SDSU team leader for the APLU project and others had heard and spoken with Dr. Yopp at an early national APLU project meeting:

> "We would not have known of him except for the APLU project."

# Spreading a STEM Department's Changes in Education to More STEM Departments

## This document is a brief description of notable changes in science, technology, engineering and mathematics (STEM) education and teacher preparation at the **University of Arkansas (UArk)**.

The described changes were prompted in part by this campus's participation during 2009-2012 in an NSF-funded project of the Association of Public and Land-grant Universities (APLU).

This case study was conducted by the external evaluator for the APLU grant, Ted Britton, Associate Director of WestEd's Program for STEM. It is based on evaluation data acquired during the project, but particularly from a two-day site visit in March 2012.

### Case Overview

Prior to the APLU project and over several years, key faculty in the physics department at UArk had enhanced physics education and increased the numbers of students who pursue teacher preparation. This was accomplished through such strategies as improving instruction in introductory physics courses and strengthening collaborations with faculty in education and other colleges.

Recent participation in the APLU project enabled physics and education faculty to collaborate with central campus administration to prompt similar changes in other STEM departments. By the time of the case study visit, notable changes favoring stronger STEM instruction and teacher preparation were well underway in the mathematics department and being launched in the biology and chemistry departments.

The active involvement of a new provost, Sharon Gaber, was one key influence for the genesis and implementation of spreading stronger attention to STEM teacher preparation and production. She formally co-led the local APLU project team at UArk along with physics professor Gay Stewart, a lead change agent for prior enhancements in physics teacher preparation. A special national APLU project meeting for provosts was key to gaining the provost's strong involvement and in providing prompts and ideas for some changes at UArk. Additional administrators who manage STEM education and STEM teacher programs (particular deans, associate deans and department chairs) also were important influencers for spurring implementation.

The most prominent strategies for increasing numbers of students pursuing a teacher preparation path were stronger direct recruitment of STEM majors into the teacher preparation program but also enhancing introductory STEM department courses. The latter strategy improved students' learning and course success, increasing the pool of students retained in STEM majors and thus available to consider pursuing STEM teacher preparation. This case briefly illustrates the above

strategies and more extensively describes how APLU project participation helped leverage the spread of these strategies from the physics department to other STEM departments.

## Institutional Context

The University of Arkansas is the state's flagship university, serving 23,000 students. It is an R1 institution with strong accomplishments in STEM research. During the APLU project, a student's typical route to STEM teaching was a 5th year education program after obtaining a degree in a STEM major. (However, the institution was exploring potential bachelor degree routes to teaching at the time of the March case study visit.)

### Non-optimal status of teaching and teacher preparation within strong STEM research programs

Across the nation and over decades, it has been very common among institutions with strong STEM research programs for STEM department chairs and faculty to place less than optimal mission, status and efforts on STEM course instructional quality and recruitment of majors into STEM teacher preparation; overall, UArk has not been an exception. Compared to the hopes of the education college and isolated STEM faculty advocates of teacher preparation at UArk, many STEM faculty and departments heads have not often given strong attention to the teaching of introductory STEM courses and teacher preparation efforts. For example, the state's K-12 school enterprise could benefit from more production of STEM teachers by UArk, particularly because graduates do come from an institution that can provide a strong STEM disciplinary background.[12] The following quotes illustrate this context:

> "Historically, it's often been hard to find faculty in the arts and sciences college who are interested in education issues and teacher preparation." [campus administrator]

Such common and understandable structural and/or cultural challenges that commonly exist within institutions are not generally understood by the public, or sometimes by students. This is illustrated by remarks from a UArk teacher graduate who was interviewed during the case study:

> "From the outset, I thought they must be working together since they all have something important to do with teacher preparation. They are smart, and they

[12] Compared to historical supply and demand analyses for teachers in Arkansas, teacher layoffs caused by the recent economic downturn have made it more confusing to diagnose the overall state demands for new teachers; however, the strong-STEM-background graduates from UARK often are valued.

are scientists and mathematicians, so they must put a premium on what's rational. But it has really been interesting to see the reality of the disconnect." [STEM teacher, UArk graduate]

### Specific challenges for education in STEM departments

More specifically, STEM faculty attention at UArk to STEM education and scholarship about it has not been well received in promotion and retention considerations; again, there are very few institutions in the country where this situation is any different. A second specific is that introductory courses in most STEM departments are dominantly taught with didactic methods rather than other instructional methods that can promote greater student success in learning STEM, for more students.[13] Finally, STEM faculty have not necessarily been supportive of talented STEM majors pursing a teacher career after receiving their bachelors degree, as illustrated by the following comment:

"In the past, I've felt there were STEM faculty who perceived us as poaching talented STEM students who should go on to graduate work in STEM instead of teaching; a STEM department faculty member might look disappointed and say something like 'Oh, that great student is going into teaching.'"[faculty member in education]

### Baseline changes in physics education

Prior to the APLU project, the greatest level of effort in the physics department's work to increase teacher production went into changing instruction in introductory physics courses. The foreground goal was to increase student course success, toward creating a larger pool of prospective physics majors; the pool of prospective engineering majors also was increased, because physics is a gateway course for engineering. The change approach was to revise instruction from didactic methods that typically weed out many students to other methods, such as inquiry-oriented instruction, which research has shown to foster deeper understandings for a wider range of students. Both the physics

[13] At the outset of NSF's Mathematics and Science Partnership Program (MSP) over a decade ago, there were strong hopes by its program managers and the then-NSF Deputy Director responsible for Education and Human Resources (EHR) that grantees would not only focus on the partnerships between K-12 schools and universities, but that universities would reinvigorate undergraduate STEM instruction to be consonant with research on effectiveness for students' STEM learning as documented in K-12 settings. It is interesting that at some sites in this APLU project, which is funded by that NSF MSP Program, there has been such attention to and success with enhancing undergraduate STEM disciplinary course instruction; this UArk case serves as an example. The local APLU co-leader Gay Stewart also has a major local NSF-MSP grant, independent of the APLU project.

department and the engineering college have been very pleased to see higher course enrollments and completions. The resulting increase in physics majors also inherently increases the pool of prospective teacher preparation candidates. Further, the kinds of instruction experienced in introductory courses also piques students' interest in physics teaching.

Key physics faculty collaborated with education college faculty on making these instructional changes, increasing recruitment into teaching programs, and on aligning the instruction in physics and the secondary science methods course in the teacher preparation program.

## Engaging the Provost and other Administrators Prompted and Enabled Stronger Attention

APLU project activities and particularly a national meeting designed specifically for provosts from participating institutions were critical in enlisting the UArk provost's involvement. The provost become co-leader to the local APLU project team, and took a range of actions to support and lead the project. This is a rare instance among the 25 institutions participating in the APLU project of a provost being a formal/named co-leader of the local APLU project team. While many other provosts actively supported local action, the local APLU team leaders usually were college deans or department chairs.

These provost actions clearly secured the attention of a wide range of stakeholders across the campus, including STEM faculty and administrators who were not previously involved in educational issues in substantial ways. It should be noted that the now-president of UArk formerly was the dean for arts and sciences and had attended an early national APLU project meeting as part of the UArk project team; therefore, he supported the provost's focus on this project.

### APLU project engagement of the provost

Locally, the local APLU project leader solicited the provost's attention to the project within weeks of the provost's arrival on campus, and gained her enlistment as co-leader. Subsequently, during grant year two, the national APLU project leaders decided to convene a special, two-day meeting for provosts in the project, accompanied by their designated local APLU project team leader. Provosts from 60% of institutions attended, including the UArk provost and her team co-leader. This national project event attracted and empowered stronger involvement by the provost.

For example, prior to that meeting, the provost did not feel equipped with a sufficient level of detail about the national project and its implications for UArk to be as active as she was interested in being. There was time at the meeting for the provost to hear from APLU staff, conference speakers and provosts from other institutions, and there was also protected, sustained time to reflect with team co-leader Stewart. Afterwards, the provost felt comfortable back on campus with actively leading some project meetings, in contrast to a prior role that had been more limited to attending and supporting them.

Throughout the project, the APLU project staff was very deliberate about deciding how often and how much to communicate with provosts, who can often receive 200-300 emails per day. The UArk provost felt that APLU communications were quite strategic in their frequency ('not too often'), timing ('just in time'), length ('not too long and the right level of detail'), structure ('making

requested actions clear') and substance ('useful/appropriate'). This APLU staff attention to communication details, in concert with prompts from the UArk team co-leader, helped attract and maintain the provost's interest and engagement in the project.

### Provost actions

Early in the project, the provost took a range of actions to lead and support local implementation, such as the following:

- convened and later co-led project meetings;
- held some meetings in high-profile campus locations;
- recruited participants for meetings;
- appointed the dean of the education college to be chair of the search committee for hiring the new dean of arts and sciences;
- collaborated with a dean and department chair to recognize STEM faculty scholarship in education; and
- sponsored an institutional grant proposal that would involve spreading and increasing STEM education innovations across the campus.

Project meetings drawing participants from many departments and colleges were held a few times per year. The fact that the provost was engaging in this initiative in the weeks right after her arrival on campus further heightened participants' perception of the initiative's importance at UArk. The provost planned to personally lead additional actions after these launch-phase activities but had to take medical leave for a sustained period of time.

A couple of interviewees remarked on the actual significance of the seemingly minor consideration of holding some meetings in a high profile location; for example, holding a meeting in the Chancellor's offices signaled to all participants that this initiative was viewed by the campus leadership as very important, and, therefore, gained their heightened attention. Appointing the education college dean to be chair of the search for the arts and science dean structurally fostered increased collaboration on education issues by the newly hired dean from the outset of her tenure. A STEM faculty member successfully went up for promotion to full professor based in large measure on substantial scholarship in STEM education and some resulting external funding that it attracted.

### Involvement of provost and deans creates conditions for spreading increased attention to education

The highly visible involvement of the provost definitively gained the attention and participation of deans, department chairs and faculty, including people who previously had not been active in enhancing STEM education and teacher preparation. One indicator of how influential her support became is the fact that when she took medical leave, participants continued to attend meetings and carry out project activities. Several interviewees reported that there had been interested faculty in some STEM departments who previously felt somewhat deterred from pursuing changes due to an

unsupportive departmental climate; they saw this as changed or changing, as illustrated by the following comment:

> "Having the provost so highly visible in her support sanctioned participation by individual faculty who needed encouragement or support in their departmental context. The provost can reach across colleges and put people together in the room." [chair of a STEM department]

The support and involvement of the deans and associate deans of the colleges for education and arts and sciences also influenced implementation. As noted, the two deans of these colleges developed a working relationship through the search process for the new arts and science dean. This and other collaborations have led to a nascent cross-campus committee on STEM education and teacher preparation that has met and plans to continue meeting regularly beyond the end of the APLU grant. This committee could seed the ability of UArk later to establish a cross-campus STEM education center, an out-years goal that the UArk team submitted to APLU as part of its strategic plan for participation in the recent project. In fact, the UArk central campus administrations has authorized an internal budget of $1.3M in funds and in-kind contributions for UArk to become a UTeach replication site, which will further empower creation of a center with an assigned physical space.

### STEM Departments Increase Attention to STEM Education and Teacher Preparation

> "Having chairs from different departments involved deepened efforts that were just faculty-to-faculty previously. Certainly this began conversations that have opened up new collaborative possibilities for major efforts that we need to undertake." [APLU project team co-leader]

The APLU project helped spur and create conditions for spreading the kinds of earlier changes in the physics department to other STEM departments at UArk. Clear changes were underway in the mathematics department and preliminary changes were taking place in the biology and chemistry departments as well. Project participants hope also to more strongly engage engineering faculty in such changes in the future.

The fact that unfolding changes began in the physics department may have given gravitas to the notion of spreading changed instructional methods into other STEM departments. It is common for physics to be viewed as the one of the most 'hard' sciences and for teaching methods to be the most didactic. Project participants at UArk "in the back of their minds may have thought, if physics can do this, anybody can." (UArk faculty member)

### Strong mathematics and education faculty collaboration

Collaborations between the mathematics department and education college have resulted in almost doubling the number of mathematics majors who have declared their intent to pursue teacher preparation in the fall, going from about 6-7 per year to 13 in spring 2012. Faculty in mathematics education and mathematics have collaborated in a range of ways:

- mathematics education faculty are invited into courses for mathematics majors to discuss mathematic teaching careers;
- mathematics education faculty provide some professional development for graduate teaching assistants;
- faculty in education and mathematics are developing a more shared strategic vision of educative mathematics teaching that benefits both mathematics majors and prospective mathematics teachers; and
- the mathematics department chair experimented with teaching a mathematics course using inquiry methods as an exploration of changed instructional methods.

Interviewees reported that in the past, mathematics education faculty had instances of feeling the mathematics department faculty only saw weaknesses in their mathematics; similarly, the education faculty was prone to focus mostly on weaknesses of instruction by mathematics faculty. Now, both faculties tend to see the strengths offered by the other, with mathematicians valuing the education expertise and education faculty valuing the deeper mathematics content knowledge and/or experience with using it.

### Early starts in biology and chemistry departments

Similar changes are beginning in the biology and chemistry departments as well.

- The departments are exploring ways to alert students to teaching career options. (For example, an education faculty member reported being surprised to hear biologists telling pre-med students in their biology service courses that they might also want to consider teaching as a career option.)
- Faculty have been identified who are willing to mentor biology pre-service teachers.
- The number of chemistry and biology majors pursuing teaching already has slightly increased.
- Experiments are planned in revising service course instruction.
- The chemistry department is exploring adaptations of its supplemental instruction (SI) sections for students who are challenged in introductory chemistry, and the mathematics department has created SI sections.

The chemistry department is considering adaptation of some of the elements of the Learning Assistants model developed in physics at UArk, which is antecedent to a model from the University of Colorado-Boulder that was featured at national APLU project meetings. The mathematics department is using a hybrid model that implements some features of each.

# Moving Campus-Wide Stakeholders from Ad Hoc Incidents and Players to Systematic Actions

## This document is a brief description of notable 2009-2012 changes in STEM teacher preparation at **The University of Maryland at College Park**.

The described changes were prompted in part by this campus' participation in an NSF-funded project of the Association of Public and Land-grant Universities (APLU). The APLU grant's external evaluator, Ted Britton of WestEd's Program for Science, Technology, Engineering and Mathematics (STEM), created this brief case study. It is based on evaluation data acquired during the project, but particularly from a two-day site visit in April 2012.

### Case Overview

> "We've had a lot of initiatives for STEM education. But the APLU project has created a focal point for those efforts and helped us pull things together. It also has increased a sense of shared responsibility across the campus for advancing STEM teacher preparation." [APLU project team leader at U.Md.]

This short case primarily highlights a new campus-wide University Teacher Education Council (UTEC), which was strengthened as part of the university's participation in the APLU project. The Council formally meets several times a year to tackle challenges and develop institutional advances in teacher preparation, particularly in the STEM education fields. Participants are high-level representatives from the central campus administration plus colleges that are stakeholders in teacher preparation. The UTEC was formed and functions under the auspices and active catalysis of the Provost and the local APLU project's team leader, Donna Wiseman, Dean of the College of Education.

The case more briefly illustrates that notably more cross-institution conversations are occurring not only among a range of administrators but also among individual faculty in STEM disciplines and STEM education across different departments and colleges.

Finally, the case notes a few other of the many campus changes in STEM teacher preparation, ones that trace part of their genesis or execution to College Park's participation in the APLU project:

- increasing the amount and ways of recruiting students into STEM teacher preparation; and
- enhancing training and use of learning assistants in STEM content courses.

This case represents an existence proof that such changes can be effectively spurred even when some key project leaders do not have educational backgrounds involving STEM fields, and when substantial and stressful over-arching organizational changes are taking place.

## Institutional Context

This large flagship institution of the Maryland state university system has a strong history and continuing priority of attention to education in the STEM disciplines and STEM teacher preparation. For example, the faculty attracts substantial external funding from the National Science Foundation (NSF) and other federal funding for nationally significant initiatives in STEM education, including some for teacher preparation. The university also wins project funding from the state such as Improving Teacher Quality grants from the higher education commission, and a portion of Maryland's Race to the Top funding, which is targeted on enhancing prospective elementary teachers' ability to teach STEM subjects.

These discrete projects and others often prompt some cross-department and cross-college administrator and faculty interactions. However, such interactions frequently involve ad hoc sets of people acting through varied informal means, and often with a focus on addressing institutional challenges specific to optimizing execution of the funded projects.

### A high priority of the state university system

This campus was amenable to addressing the APLU charge to enhance STEM teacher preparation in part because the Maryland state university system previously and especially recently has emphasized this priority with its member campuses, including expectations for cultures of intra-campus collaboration around STEM teacher preparation. The university system has done steady and strong messaging, which has been taken seriously at College Park; several interviewed administrators made unprompted mention of a policy emphasis on STEM education by state university system leaders and the state Governor as an influential force in emphasizing their attention to it.

### Robust action despite major cuts and re-organizations

The period of this grant was a particularly problematic moment for the College Park campus to take on such an organizational challenge as establishing the UTEC: The College of Education was re-organizing into fewer departments; the provost left after the first years of the APLU project and an interim provost has been in place since then; there was an unexpected wave of departures by science education faculty; there was a change in the Dean position for the College of Computers, Mathematics and Natural Sciences; and budgets were undergoing severe cuts and changes due to the economy.

### Led by administrators without STEM backgrounds

The success of the APLU-influenced initiatives despite the above challenges was often attributed by interviewees across campus to the strong and effective championing by Dean Wiseman with other campus administrators. Her efforts were supported and prompted by the tracking and catalyzing of initiatives by associate provosts, particularly given the change in the provost position during this project.

In the other three sites visited for the APLU grant evaluation, key project leaders had backgrounds in STEM disciplines or STEM education, which could strengthen the natural gravity of their attention and energy to this issue and increase their understanding of subject-specific particulars of issues in STEM teacher preparation. In contrast, this case illustrates that having local leaders with subject-specific backgrounds was not by itself a requisite for participating institutions in the APLU project to make significant strides. However, Dean Wiseman also enlisted STEM knowledgeable staffing, for example: Dan Chazan, Coordinator for the CoE Division of Science, Technology, and Mathematics Education, aided Wiseman with a range of campus STEM teacher preparation initiatives.

## The University Teacher Education Council

While attention to many STEM teacher preparation initiatives at College Park received a boost from having the imprimatur and catalysis of participating in the APLU project, interviewees viewed establishment of UTEC as the initiative most clearly being influenced by participation in the APLU project.

The University Teacher Education Council (UTEC) meets regularly to systematically address institution-wide issues. And members focus not only on addressing issues at hand but they also proactively identify and advance enhancements in teacher preparation, particularly in STEM areas.

### Aided by APLU Imprimatur and Project Activities

When several of College Park's APLU project team members attended an early APLU project meeting, it afforded them "very useful", protected, sustained, formal and informal time together – considerably more than this set of administrators from different parts of the university would readily be able to find or likely to seek out on their own at home. The meeting strengthened the U. Md. team's good, prior relationships, enhancing subsequent communication and follow-through back at College Park.

Also at the early APLU project meeting, U. Md. participants experienced from the collective with all 25 institutions' representatives the national gravitas of the APLU project. They more fully realized the spotlight and opportunity that the APLU publicity afforded institutions, but also realized an increases sense of responsibility to fulfill the project's charge. These realizations gave impetus to the U. Md. representatives' consideration of ambitious changes that would be most consistent with the nature of the APLU project, i.e., ones that are systemic and at the institutional level.

The diffuse yet palpable sense of responsibility for institutions to fulfill the APLU charge helped catalyze the U. Md. representatives to take on the complex practical and political endeavor of establishing the cross-institution UTEC and making it functional. While the institution may have proceeded at some point to do something like the UTEC, interviewees felt that the APLU project can be credited with ensuring that it happened now, moved quickly, and with a more ambitious design than likely would have happened in the absence of the APLU spotlight, opportunity, and support.

### Making significant organizational changes

Interviewees shared these examples of UTEC work on institutional programs and procedures that will impact STEM teacher preparation:

1. Require STEM disciplinary departments to analyze and describe implications for STEM teacher preparation in every request for changes in courses offered (advanced UTEC proposal).
2. Require every college with a stake in teacher preparation to establish its own committee on teacher education, with committee representatives to serve on UTEC (advanced UTEC proposal).
3. Require all university faculty to report any significant work that they are doing with K-12 schools (proposal in development).
4. Achieving institution-wide consensus on whether to add an outside model for STEM teacher preparation when colleges had significantly conflicting views (completed).
5. Raising the student grade point average (GPA) required for admission to teacher preparation programs when colleges had significantly conflicting views (completed).

The first proposal is important to teacher education because, for example, there have been past instances when a STEM disciplinary department dropped a course that was not critical to its majors, with or without knowledge that the course did have an important role in the scope and sequence of STEM teacher preparation. The new requirement will enable the College of Education to be aware of proposed changes that could impact STEM teacher preparation and more readily confer with other university units on the course's future.

The second proposal will help UTEC extend its reach into relevant colleges and help improve an uneven level of knowledge about and attention to teacher preparation issues among relevant departments within some colleges. An impetus for the third initiative is that the university wants to increase its relationship with area schools regarding teacher preparation and several other ways, but currently does not have a systematic means of knowing the spectrum of ways in which faculty already are interacting with them.

Regarding the fourth item, some departments and colleges had wanted to adopt an outside teacher preparation program. Prior to UTEC, these university units probably could have moved forward unilaterally. Within UTEC, they accepted the concerns of other colleges and departments and changed course by not adopting the model. While advocates had some disappointment, the decision to use UTEC and honor consensus may increase participants' buy-in for future UTEC work.

Such goodwill may already have contributed to deliberations of the fifth item. The College of Education advocated raising the GPA requirement for entering teacher preparation with a stance of wanting to increase numbers of STEM teachers, but not at the expense of teacher quality. Some non-STEM colleges were resistant, because they understandably would prefer to continue having education as a candidate post-baccalaureate opportunity for as many of their students as possible. Because of stronger relationships now forged between some STEM departments and the College of

Education, these STEM departments (through their college representatives on UTEC) helped the CoE champion the proposal for an increased GPA entrance requirement.

### Holding regular, informed, productive meetings

The UTEC typically meets twice per semester to consider agenda items about campus-wide issues and ideas for enhancing teacher preparation. The Council annually devotes at least one meeting to discussions with a wider group of advisors from across and beyond the campus, including external stakeholders such as superintendents of large, nearby school districts. A Council leader remarked: "I really see a reality check going on in both directions" [university and outside stakeholders].

Between meetings, Council members talk with advisors and other faculty and prepare, collect and consider information and data as necessary for making substantive progress on agenda items at the meetings. Because meetings have been strongly attended by Council members rather than by substitutions, there has been continuity and momentum in Council business thus far in its brief history. Many Council members have interacted previously over the years to discuss or work on issues in STEM teacher preparation. But establishing the high-level UTEC has made these interactions routine and scheduled, permitting issues and ideas to be addressed more systematically and effectively. Further, organizers have enlisted a larger group of stakeholders.

### Engaging high-level administrators as participants

The more than a dozen Council members are high-level representatives of the central campus administration (i.e., two associate provosts) and of colleges that are stakeholders in teacher preparation, such as both assistant and associate Deans of the College of Education, and associate deans of Graduate Studies and the cross-campus division of Undergraduate Studies that is responsible for undeclared majors.

Other teacher education stakeholder representatives specific to STEM teacher preparation are the coordinator of the CoE's Division of Science, Technology and Mathematics Education and associate deans from the colleges providing STEM content courses taken by prospective teachers: The College of Agriculture and Natural Resources as well as The College of Computers, Mathematics and Natural Sciences.

The College of Engineering is not formally represented because it currently does not have a strong ostensible role in STEM teacher preparation. However, the UTEC leaders would like to see more future involvement by the engineering college for two reasons: among engineering majors who end up considering alternate career goals, more of them might be recruited into STEM teacher preparation; and national STEM education policy quickly is increasing the call to more strongly address the E in STEM education.

Being constituted with high-level administrators empowers the Council to systematically handle institution-wide issues and strongly leverage execution of Council decisions and plans. For example, when associate deans advance initiatives through the UTEC, they can have confidence that an associate provost will give the provost a heads-up of emerging ideas and bring the provost's feedback into the next meeting's discussion, if/as needed. For those knowledgeable of U.S. Congress' functioning, perhaps the following is an analogous model: Often it is senior staff to

congressmen or senators that confer, do research, and forge draft legislation. Staff runs developments by their principals so that legislators can be comfortable later when acting upon the actual bills.

Some interviewed faculty look forward to the possibility of the Council increasing dissemination of information and strategic expansion of participants. Such a change could prompt further advances in institutional process: making the level of familiarity with Council actions more even among faculty in different departments within colleges; generally increasing buy-in and execution at the departmental and faculty levels; and enabling department chairs and faculty to more readily inform and contribute to Council activity.

## Other STEM Preparation Changes Influenced by APLU Project

### Teaching assistants to enhance learning in STEM content courses

One way to increase numbers of STEM teachers is to enhance their retention through the course of a STEM teacher preparation program. A key strategy is addressing a common stumbling block – helping students to succeed in challenging STEM content courses. The university's APLU project team was intrigued at an early APLU project meeting with presentations about the Learning Assistants program at the University of Colorado-Boulder, wherein students are aided in STEM content courses by assigned learning assistants.

The University of Maryland already had some versions of learning assistants, but was prompted in part by the APLU meeting presentations to give further attention to such programs and make some adjustments. Undergraduate assistants in STEM content courses are required to participate in a one-credit course, "Introduction to Teaching". Details vary by STEM department, e.g., the microbiology department requires teaching assistants to participate in three credits of training.

### More and different ways of recruiting for STEM teacher preparation

At the outset of the APLU project, leaders presented an Analytical Framework for STEM Teacher Preparation to the 25 participating institutions. It enables a campus to comprehensively consider strategies that could impact the phenomenon. Across the APLU project, one goal that particularly caught participants' attention is the logical but often weakly addressed strategy of paying stronger attention to recruitment, i.e., institutional diagnosis of any/all ways to more concertedly and systematically recruit students into STEM teacher preparation. One major challenge for this strategy can be overcoming bias by STEM disciplinary faculty against the prospect of their most talented undergraduates pursuing teaching as worthwhile career path.

The genesis of the following efforts was spurred by local interests rather than by the APLU project. However, the APLU Analytical Framework raised consciousness about recruitment and further supported the university's attention to these issues and programs.

The University of Maryland is enhancing student recruitment into its existing, traditional teacher preparation programs. For example, the previously described learning assistants program has a secondary prospect of familiarizing teaching assistants with STEM teaching, which could result later in some of them entering STEM teacher preparation. The university also has a range of strategies expressly intended to increase recruitment:

- having advisors available within STEM departments that can give informed explanations about STEM teaching and teacher preparation;
- creating a culture among STEM department faculty of sanctioning/supporting STEM teaching as a valuable potential path;
- having STEM education specialists briefly speak about STEM teaching in large introductory service courses of STEM departments; and
- offering a course to volunteer in schools, which could interest students in a teaching career.

Like most institutions, College Park is far from having such strategies widely or strongly executed. However, interviewees were able to offer strong exemplars of success. For example, a physicist who advises students interested in become physics teachers described recent interactions with a student who is very accomplished in physics: "Not a single faculty member tried to discourage him from going into teaching; in fact, he had the full support of the physics faculty."

The university also is increasing the numbers of students pursuing STEM teaching by experimenting with new teacher preparation offerings, through both traditional and alternative routes. These two new programs illustrate the former: one for computer science teachers, and an add-on, middle-school science certification for existing elementary teachers. A program tailored for a large local school district having a majority-minority student population is an alternative route; area STEM professionals are aided in career switching to teaching through a residency program in these schools.

### Increased faculty collaborations across colleges and departments

This case previously noted that the University Teacher Education Council has increased the types and amounts of cross-campus collaborations among administrators. Analogously, the above APLU-influenced initiatives and others occurring around STEM teacher preparation also have increased cross-boundary collaborations at the faculty level. On several occasions during the site visit, faculty representatives from varied colleges and departments came together to describe initiatives. Their dynamics and comments clearly indicated that their working relationships are productive. Further, they made such remarks as:

"I'm talking with faculty in STEM departments more than I ever have before" (professor, College of Education); and

"In the past, I've talked often with people around campus about STEM teacher preparation. But the amount of cross-campus discussion has gone way up recently. I'm talking to people now that I've never spoken with before; actually, I didn't even know who some of them were before." (professor, College of Computer, Mathematics and Natural Sciences).