Change and Sustainability in Higher Education (CASHÉ)

Final Report

University System of Maryland
March 2010

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MSP History and Context

Over the past decade, the federal government has established several incentive programs to help "prime the pump" and raise the stakes for colleges and universities to participate in P-20 STEM education reform, with a particular emphasis on the engagement of higher education faculty to lead these efforts. In 2002, Congress made an initial appropriation in the order of $160 million to the National Science Foundation (NSF), with additional funds to the U.S. Department of Education (ED) in 2003, to invest in Math and Science Partnerships (MSPs). By facilitating linkages between colleges and universities and K-12 school districts, MSP grants engage faculty in areas of vital importance for improving science, technology, engineering, and mathematics (STEM) education, including K-12 teacher preparation, K-12 teacher professional development, and STEM curriculum reform at all levels. While such activities are not traditionally valued as "faculty work" in the academy—often regarded as outreach or service, but rarely as scholarship, particularly in the STEM disciplines—they serve as the foundation of these reform efforts nationwide.

To date, NSF has funded 73 MSP projects, including "comprehensive" partnership projects that engage college and universities in broad-based reform efforts with K-12 school partners, "targeted" partnership projects that focus on specific grade levels or disciplines, "institute" partnership projects that focus on teacher content knowledge and leadership, and "start" projects that provide planning support for partnership start-up activities. By design, the five key features of all MSP projects include: (1) challenging STEM courses and curricula; (2) enhancement of teacher quality, quantity and diversity; (3) partnerships among STEM teachers and faculty at all levels; (4) evidence-based course and curriculum design; and (5) institutional change and sustainability. This last feature is perhaps the most significant, and most difficult, in that it requires partners to make a commitment to institutional changes that will lead to sustainability and institutionalization of the partnership activities.

The MSP program is an important initiative from NSF and the broader scientific community that addresses the urgent need to improve STEM education in the 21st century and expand the pipeline of students majoring in STEM disciplines. MSP projects operate in a collaborative research and development environment that seeks to increase the number of new, highly proficient STEM teachers through innovative teacher preparation programs, to improve the quality of the current STEM teacher workforce through professional development, and to enhance the quality of STEM education within IHEs for all students. Central to the success of the MSP programs are strong partnerships among K-12 school systems and higher education institutions that facilitate linkages to other key

stakeholders on the local, state, and national levels. The MSP initiatives recognize that in order to prepare the next generation of STEM professionals, we must have scientifically, technologically, and quantitatively literate K-12 teachers who are able to prepare the next generation of college students. These needs are likewise substantiated in several recent national reports (e.g., *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education; Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century; Learning for the Future: Changing the Culture of Math and Science Education to Ensure a Competitive Workforce; To Touch the Future: Transforming the Ways Teachers Are Taught; Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future;* and *An American Imperative: Transforming the Recruitment, Renewal, and Retention of our Nation's Mathematics and Science Teaching Workforce*).

Since 2002, the authors of this report have been involved in these broader national efforts through two of their own NSF-funded MSP projects, and more recently, through a subsequent research supplement from NSF called Change and Sustainability in Higher Education (CASHÉ). CASHÉ seeks to study the nature of change processes and outcomes among participating MSP colleges and universities across the nation, including the impact of the partnership activities on college and university faculty. This research suggests that while faculty leadership is a necessary requirement for reform efforts of this scope and nature, it is not necessarily sufficient to effect sustainable institutional change. On the other hand, institutional change cannot come about solely through administrative mandates or external calls for accountability. The evidence collected from this project suggests that faculty who lead these efforts often work outside of the established roles, norms, and boundaries of their institutions, at least initially. At the same time, there is evidence of real change in many institutions where faculty efforts have shifted from "marginal" to "mission-central" as a result of participation in MSP partnerships.

The Faculty Context in Higher Education

Recent alarms about America's global standing and competitiveness have resulted in urgent national "calls to action" for developing a better trained workforce, a more scientifically literate citizenry, a stronger research and development infrastructure, and an expanded pipeline of students, educators, and other professionals in the STEM fields. These issues have been well documented in several high-profile reports over the past decade. For example, *Rising above the Gathering Storm,* the much acclaimed report from the National Academies (2007), examined trends related to the nation's contribution to the global workforce, and advised that if urgent action were not taken immediately, the United States could expect to lose its advantage as a world leader in science and technology. In addition to such policy-oriented reports that call for STEM reform nationally, there is a growing body of research literature that focuses on change in STEM education and instructional practices on college and university campuses (see Henderson, et al., 2008, for a recent synthesis.)

Given this national and international context, increased attention has been paid to the role that colleges and universities—and their faculty—should play in strengthening the STEM education system and expanding the STEM pipeline, not just in higher education, but across the entire educational spectrum, including K-12. In response, the federal government has established several incentive programs to help prime the pump, including the MSPs—raising the stakes for colleges and universities to participate in STEM education reform efforts. In many of these programs, higher education faculty have been called upon to play an active leadership role—by reforming courses and instruction at the college level, by getting involved in the preparation for future teachers, or by lending their expertise to the professional development of in-service K-12 educators. It is important to acknowledge that higher education faculty have a long history of grassroots involvement in educational reform efforts, including the alignment and review of courses and curricula (both at the K-12 and college levels); the development and delivery of workshops, institutes, and courses for K-12 teachers to increase their content knowledge and pedagogical skills; participation in learning communities with K-12 teachers; and direct service as a content resource or teaching mentor in K-12 schools (Greenberg, 1991; Wallace, 1993; Timpane & White, 1998; Verbeke & Richards, 2001; Wiseman & Knight, 2003; Zhang, et al., 2007). However, such activities are not traditionally valued as faculty "work" in the academy.

Research universities clearly present one of the more challenging contexts for the emergence of this work, given the clear demands for research and scholarship that dominate institutional missions and cultures. Yet, the landscape is gradually shifting: faculty at many other types of four-year institutions are increasingly held accountable to similar incentive structures that reward faculty work in research universities. (See Neave, 1979, for a discussion of the concept of "academic drift" in higher education, the tendency for institutions to imitate other types of institutions—particularly research universities—in order to gain prestige and status.) Additionally, community college faculty are frequently called upon to partner with K-12 schools through such activities as providing professional development workshops for teachers or offering content courses for teacher recertification. Even for community college faculty, however, K-12 involvement is not typically included in their academic workload.

Thus, faculty who choose to become involved in these initiatives—who are typically rewarded for research, scholarship, and teaching—are finding more of their time invested in activities that fall outside of the traditional boundaries for faculty work. While it is typically faculty members themselves—through the process of peer review for juried publications and tenure and promotion decisions—who determine the value and relative worth of the various strands of activity that define faculty work (Fairweather, 2002), it appears that for the most part, traditional faculty reward structures have not yet been recalibrated to incorporate these emerging roles and responsibilities (O'Meara, 2006). Without accepted standards for practice in the academy, it is difficult for deans, promotion and tenure committees, and faculty peers to actually evaluate the quality of faculty work with schools. By examining this phenomenon in the context of NSF's MSP projects, our research seeks to build an emerging understanding of the role of faculty in

such change efforts, as well as the complex interplay between faculty leadership, administrative leadership, and institutional culture and context.

The Institutional Context in Higher Education

This section reviews literature related to the researchers' main assumptions about institutional change when developing our research study on the impact of the MSPs: 1) change in higher education requires more than top down leadership; 2) faculty leadership requires support from top down leaders; 3) institutional culture shapes change processes and leadership; and, 4) change processes may also require shifts in institutional culture to be sustainable.

Difficulty of top down leadership efforts in higher education

As Eckel and Kezar (2003) have observed, top down leadership efforts aimed at change are typically not successful in higher education due to the way that colleges and universities are structured. While traditional management theory and practice in the United States tend to be more top down and emphasize the role that individual leaders and organizational processes play in change, there are limitations to applying such frameworks that do not incorporate the unique cultural perspectives of higher education. Cohen and March (1974) characterized college and university environments as "organized anarchies" that are not receptive to top down leadership and hierarchy, and that operate similar to other professional bureaucracies with defining characteristics of a service mission, professionalism, goal ambiguity, problematic technology, and environmental vulnerability. Additionally, Weick (1976) likewise identified higher education institutions as "loosely coupled systems" with complex parts that are tied together frequently and informally rather than along tight linkages or hierarchical lines. Furthermore, Kezar (2001) identified a number of organizational characteristics of colleges and universities that make top down change processes difficult including their multiple power structures, distributed decision-making and authority, shared governance processes, professional and administrative values, and the presence of competing goals and outcomes. Such analyses all reinforce organizational complexities of colleges and universities and the need for distributed leadership to create change.

The role of top down leaders

Shared leadership models in higher education suggest that top down leaders may still be important to support bottom up leadership. This is particularly important in light of barriers related to faculty roles and reward structures that earlier research suggests may create barriers to faculty practicing grassroots leadership (Frank & Shapiro, 2007). Change processes in higher education can become protracted when grassroots leaders are distributed in various places across campus, and it often takes a positional leader with some level of authority to unify these efforts (Kezar, 2001). In addition, change efforts at the grassroots level often require top down support in order to be institutionalized, as they

typically have broader administrative implications—including enhancements to infrastructure, development of new policies, and increased fiscal and human resources.

This dilemma of blending top down and bottom up leadership is captured by Hearn (2006) in his research on leadership and change that identified one of the major challenges for institutional leaders as balancing external demands for accountability, which often call for executive style leadership, with more traditional processes of shared governance and distributed leadership on college and university campuses. Most academic leaders, including college presidents, have come up through the ranks of the faculty themselves, and therefore understand this unique cultural context of shared governance (Peck, 1983).

The role of institutional culture and context

One of the premises of this study is that organizational culture and the context for change in higher education play a significant role in shaping the extent to which faculty leadership in such areas as STEM educational partnerships is valued and rewarded. Kezar and Eckel's (2002) study suggested that change processes in higher education are largely shaped by institutional culture. They found that while there are various general tactics or strategies that work to create change in organizations, change strategies in higher education seem to be most successful when they are contextualized for the specific institution. In examining 26 colleges and universities that were involved in varying types of institution-wide change initiatives, they found that institutional leaders are more successful when they choose strategies and tactics that are relevant and a fit with the culture. They observed that change strategies that consider institutional mission, history, and values are better positioned to facilitate change because they are more likely to resonate with members of the campus community and be met with less resistance.

Building on Kezar and Eckel (2002), Merton, et al. (2004) noted that organizational culture was a critical variable in understanding curricular change processes in undergraduate engineering education. Without a clear understanding of institutional culture before launching these curricular change initiatives, they saw faculty leaders struggling with such issues as persuading fellow faculty to use the new teaching innovations, gaining the necessary departmental and college level approvals, needing to create new structures to coordinate and sustain the programs over time, and keeping up with collaborative relationships across disciplinary and college boundaries. They observed, "The point is that there was no one strategy, no ideal change model, or no universal process that could be applied to each situation that would guarantee successful adoption of these new curricula" (Merton, et. al, 2004, p. 2). Rather, faculty members had to understand their institutional context well enough to know what approaches would be most effective, and implement culturally relevant strategies for overcoming obstacles and barriers when they arose. Frost and Teodorescu (2001) went a step further in their views of faculty curricular reforms at research institutions. They asserted that changes involving the curriculum and the teaching and learning environment should be considered as forms of institutional culture change in and of themselves, as these investments of faculty time and effort serve to enhance and legitimize the value that institutions place on

such activities. These studies collectively suggest that change efforts in higher education are heavily shaped by shared governance and institutional culture.

Changing institutional culture

At the same time, neither top down administrative leadership nor faculty grassroots leadership may yield sustainable change or result in widespread adoption of new ideas or methods unless a cultural shift takes place in tandem with such developments. Gaining support for culture change is a complex process. Lewin (1951) and Schein (1997) noted that organizational culture must change or shift in such a manner that the desired state replaces the existing state. Applying these change perspectives to higher education, Ewell (1997) described institutional change as requiring constant and consistent leadership, a fundamental shift in perspective, individuals and organizations to relearn their roles, and systematic ways to measure progress and guide improvements. Further, Burack and Saltmarsh (2007) posited that in order for institutional changes to transform into institutionalized practices, they must become routine, widespread, legitimized, expected, supported, permanent, and resilient, rather than those that are marginalized, occasional, isolated, unaccepted, uncertain, weak, temporary, or at-risk. Likewise, Levine (1980), in examining the innovation process at 14 colleges and universities, stressed that innovation efforts in higher education do not tend to become institutionalized unless such changes are congruent with underlying shifts in culture and therefore consistent with institutional values, norms, and goals.

Additionally, it is important to note that the culture within STEM disciplines has been cited as a roadblock to change in reform efforts. STEM faculty themselves have stated that while their institutions may publicly support faculty involvement with K-12 schools and teachers, there are few incentives for faculty to substantively participate in such activities (Frank & Shapiro, 2007). The premiere rewards structure in the STEM disciplines is shaped by external funding for scientific research, development, and discovery. Work that does not directly contribute to this end is often viewed as a deterrent, particularly for tenure-track faculty. Furthermore, K-12 outreach has traditionally been seen as something that faculty in colleges and schools of education should be responsible for, rather than drawing from a broader base of institutional support and responsibility. This disciplinary lens adds yet another layer of complexity to the process of changing institutional culture, yet it is important to recognize the role and potential impact of the academic disciplines, each of which offers its own forms of faculty rewards, and shapes the professional identity of faculty members.

CASHÉ Project History

In 2004, the University System of Maryland (USM) received a supplemental grant from NSF to study a broad range of issues related to institutional change, and to examine the effect of MSP projects on changes in higher education that strengthen STEM faculty involvement in undergraduate teaching and K-12 educational reform. This study, *Change and Sustainability in Higher Education* (CASHÉ), built upon the work of USM's

targeted MSP project, *Vertically Integrated Partnerships K-16* (VIP K-16), involving multiple colleges and universities in Maryland that were focused on increasing the engagement of STEM faculty in teacher preparation, K-12 partnerships, and inquiry-based teaching and learning in undergraduate science courses. In particular, VIP K-16 raised a number of questions about the constraints and facilitators that affect faculty and institutional engagement in MSP work. Thus, through CASHÉ, USM proposed to study some of the questions and issues raised by its own local work in other MSP sites.

From the outset, one of the overarching goals of the CASHÉ project was to "catch colleges and universities when they were doing something right," and to identify both intermediate and conclusive indicators that suggest or demonstrate how colleges and universities can successfully engage in activities that strengthen their support of K-12 mathematics and science education and teacher preparation. Thus, some of the global questions that guided this work were the following:

- How do we identify key indicators of institutional change across different types of institutions, and what documentation can we provide to demonstrate the presence of these factors and evaluate these factors in a given context?

- What tools and instruments already exist to evaluate and recognize institutional change in higher education? In what ways are the tools and instruments being used? What new tools or instruments should be developed?

- Where do we see examples of sustainable P-20 partnerships and cultures of organizational support, and what can we learn from them? Where are there good examples from other kinds of organizations that might offer some insight into change in P-20 education?

- What can we learn about the contexts that make sustainable and intentional change possible in higher education? Where do gaps exist across different contexts and higher education cultures?

- What changes that have been supported by MSPs have made a difference in creating institutional conditions and capacity in higher education to support the reform of science and mathematics education and the meaningful engagement of faculty in this enterprise? How can we evaluate these changes?

- How can institutions of higher education provide incentives and rewards to stimulate and motivate faculty so that creative teaching and pedagogical scholarship becomes part of faculty culture?

One of the initial activities of the project was to identify and convene members of a national Advisory Board that would provide external guidance, direction, and validation for the CASHÉ study, and that would meet periodically over the course of the project. The composition of this group was envisioned as follows:

- Current or former university presidents or chancellors who have national leadership experience in STEM education and a national reputation in the broader P-20 arena

- Nationally recognized experts in the study of higher education, in the scholarship of teaching and learning, in teacher education reform, and in STEM education reform

- Leaders of scientific societies or associations who are committed to improving STEM education at all levels

- P-20 leaders with a record of successful school/university partnerships

In terms of the original project plan, the CASHÉ work was staged in three phases:

- Identify an interdisciplinary project advisory board and hire a project director. Plan and host a series of meetings to outline the project's research agenda and priorities.

- Convene working groups to address priority issues. Collect evidence from MSP projects to document institutional change (via project site visits, faculty interviews, and secondary data analysis).

- Analyze and disseminate findings. Prepare a final report and policy recommendations for future funding initiatives for NSF, and disseminate best practices and model indicators through published papers, conference presentations, and MSPnet.

Through studying the role and impact of the MSPs, the primary goal of CASHÉ was to develop, deliver, and disseminate recommendations that would lead to scalability and sustainability of successful institutional change efforts. The outcomes of the CASHÉ project, as originally envisioned, were a set of policy recommendations to be drawn from the scope of work outlined above. The primary audiences for the recommendations would be NSF, the broader community of MSP projects for which NSF has explicit expectations regarding institutional change and sustainability, and other public and private foundations and funding agencies whose mission is to prepare P-20 students to fully participate as citizens in an increasingly scientific and technological society.

CASHÉ Project Activities

This section documents various work products that have come out of the CASHÉ project, including written reports (which are included as appendices), project meetings, site visits, and knowledge dissemination activities.

MSP Course and Curriculum Report

In November 2005, NSF requested that the CASHÉ project team study a subset of MSPs in order to analyze the nature of curricular changes within participating colleges and universities that were reported as outcomes from their involvement in the project. A total of 21 MSPs provided detailed data in the form of URLs, annual reports, internal and external evaluation summaries, and other project materials. The level of analysis focused on the types of curricular change involved, the number of courses and/or programs that were developed or substantially revised, the primary audience for these changes, responsible parties (i.e., individual faculty members, faculty teams, departments), linkages with external educational standards (i.e., local, state, national, discipline-based), non-curricular and non-credit activities, and supporting evidence. A preliminary draft of this report was submitted to NSF in February 2006. A revised and expanded final version of this report (dated June 2006) is attached as Appendix A to this report.

Management Information System (MIS) Survey Analysis

Housed in the MSP-MIS (Management Information System), the *Annual Survey for Comprehensive and Targeted Partnership Projects* includes a series of open-ended questions pertaining to "Institutional Change and Sustainability" activities during the previous academic year. Two of these survey questions address topics that are directly related to the goals of CASHÉ, including higher education faculty rewards for MSP participation and faculty responsibility and accountability for MSP project goals. Open-ended narrative responses to these two questions over a three-year period were analyzed by CASHÉ project staff. A summary of these findings is written up in a separate report (attached as Appendix B), along with corresponding strategies and examples cited by individual MSP projects.

The first survey question pertaining to faculty rewards was the following: *Describe any new practices or policies that your IHE partners implemented during the last school year to reward IHE STEM faculty for (a) strengthening their own teaching practices, or (b) participating in K-20 teacher preparation and professional development programs.*

Five categories of responses were developed by CASHÉ project staff based on the themes that emerged from the data, including promotion, tenure, and merit policies; workload and monetary incentives; recognition opportunities; changes to institutional infrastructure; and professional development seminars and workshops.

The second survey question pertaining to faculty responsibility and accountability was the following: *Describe any new practices or policies that your IHE partners implemented during the last school year to encourage IHE STEM faculty to take responsibility and accountability for MSP project goals.*

Again, open-ended narrative responses were summarized and placed into a series of categories that were developed by CASHÉ project staff. The same five categories that emerged in response to the faculty rewards question also emerged in response to the

faculty responsibility and accountability question. Additionally, responses to this question suggested adding two categories: program creation/redesign and opportunities for professional collaboration. While these latter two categories may not seem to be measurable faculty "rewards" in the traditional sense, they do highlight important facets of faculty work with the MSP and the opportunities these projects have provided for intellectual contributions and networking.

Summary Analysis of NSF MSP Learning Network Conference

On January 26-27, 2007, the National Science Foundation hosted its fifth annual Math and Science Partnership (MSP) Learning Network Conference in Washington, D.C. The theme of the conference was *Engaging STEM Faculty in MSP: Promises and Challenges.* This annual forum provides opportunities for all MSP and RETA (Research, Evaluation, and Technical Assistance) projects to come together to share information, tools, and resources; network and connect with each other; and disseminate best practices and findings. The conference was attended by approximately 300 participants, with broad representation from STEM (science, technology, engineering, and mathematics) faculty. The agenda of the conference encompassed a range of presenters and topics, including

- plenary sessions delivered by college presidents who have MSPs on their campuses;
- the external policy landscape from the perspective of NSF and the U.S. Department of Education;
- presentations on faculty engagement;
- facilitated discussions on challenges, strategies, and sustainability; and
- structured breakout sessions in which individual projects shared and disseminated their work.

The CASHÉ project was asked to prepare a summary report from the conference, since its theme, the engagement of STEM faculty, was directly aligned with the project's research agenda. This report, included in Appendix C, attempted to capture and summarize the knowledge and findings that were shared about STEM faculty engagement during the conference. It began with an overview of the characteristics and effects of higher education faculty who are involved in MSP projects, the role of institutional leadership, and the broader political and social context in which MSP work occurs. It continued with a synthesis of discussions (in which all conference attendees participated) surrounding the promises, challenges, and sustainability of faculty engagement. The report then presented promising models for faculty engagement across projects, perspectives from STEM faculty members, and conceptual approaches for studying faculty engagement and MSP impact. It concluded with a summary of cross-cutting issues and themes.

The 2007 Learning Network Conference accomplished two key goals: First, it gathered together cutting-edge research and practices that had been carried out over the previous four years of the MSP program. Secondly, it surfaced some of the thorniest challenges to the success of the mathematics and science partnership work—sustaining faculty engagement. The findings suggested that faculty involvement in MSP work is important to the quality, impact, and outcomes of the projects. That being said, recruiting and sustaining high quality faculty engagement in this work is counter-intuitive for most research faculty, and real culture change will only happen when the higher education community becomes thoroughly convinced that the future of their work is dependent on their sharing responsibility for developing the pipeline for their successors. The metaphor that came to mind was "building a bicycle while you are riding it." By generating sufficient evidence that faculty involvement is critical to the improvement of K-12 STEM education, higher education can begin to make substantive changes that will ensure faculty involvement. At the same time, compelling evidence can only be collected when faculty are involved in significant ways for sufficiently extended periods of time.

Summary Analysis of NSF MSP Faculty Summit

On December 11-12, 2007, CASHÉ staff worked with members of the Center for Organizational Leadership and Change (CLOC) at the University of Maryland, College Park, to document the STEM Faculty Summit, co-hosted by NSF and the U.S. Department of Education (ED). The Summit was attended by over 200 STEM faculty representing both NSF and ED MSP projects. The Summit was designed to capture and consolidate lessons learned and best practices from these faculty, in particular, and to identify the next steps in advancing this work. The purpose of CASHÉ's report (included as Appendix D) was to highlight major themes and findings that emerged during the two-day Summit, with a specific emphasis on breakout sessions during which STEM faculty directly engaged in discussion with each other. This report was not intended to document the Summit in its entirety or to serve as a traditional set of conference "proceedings," but rather to integrate the collective knowledge and insights generated by these STEM faculty members in their individual institutions and partnerships with the broader national context of MSP work over the past five years.

In brief, the major findings of the Summit included:

- The partnership model is crucially important for addressing the challenges of improving teaching and learning in mathematics and science, and for constructing a strong, coordinated STEM education system. To transform P-20 education, we need to break down silos and work simultaneously and collaboratively. Successful P-20 partnerships understand how to tap into the strengths of higher education institutions to help support K-12 schools.

- One of the underappreciated sources for engaging higher education faculty in MSP work seems to lie deep in the nature of their personal and professional identities – their own curiosity and need to know and learn through experimentation, investigation, and discovery. Multiple pathways for faculty involvement should be

identified and encouraged and should not be limited to direct service to teachers or schools. In many projects this has involved faculty engaged in STEM education reform at the undergraduate level. However, faculty involvement must also be linked to institutional rewards and recognition, or even the best intentions will go unrealized.

- Higher education faculty who are engaged in K-12 schools are often likely to examine their own pedagogy, as innovative partnerships require faculty to move outside of their individual areas of expertise. Thus, colleges and universities should be challenged to recognize their self-interest in K-12 work.

- A unique feature of NSF and ED MSP projects compared to other reform initiatives is the systematic study of MSP experiments using recognized research and evaluation tools to gain new knowledge and understanding. As challenging and problematic as it has been to evaluate partnership projects with so many moving parts, new knowledge has been generated, new models have been tested, and research has generated evidence to support project hypotheses. The research on MSPs leads to new questions for research, building a significant knowledge base.

Among the best practices that emerged from both the NSF and ED projects were:

- Supporting STEM faculty in their roles as educational researchers in MSPs, which leads to improved STEM education in colleges as well as K-12 schools;

- Integrating research and scholarship on "how students learn" into STEM classroom teaching P-20;

- Implementing new institutional rewards systems and policies to support MSP faculty;

- Creating sustainable structures for the institutionalization of MSP work; and

- Expanding roles for the disciplinary and professional societies in promoting STEM faculty involvement in teaching and learning in the disciplines, K-12 schools, and teacher preparation programs.

Site Visits

In order to more fully explore how MSPs institutionalized a P-20 perspective in higher education and to identify successful MSP activities that strengthened higher education's support of K-12 mathematics and science education and teacher preparation, the CASHÉ project team and advisory board visited six MSP partnerships.

Selection

Selection of the sites began with recommendations from CASHÉ's NSF Program Officer which were then researched to ensure a diversity of project and institutional types – comprehensive/targeted, urban/rural, single institutions/multiple institutions, research

universities/comprehensive institutions/community colleges. All projects considered were judged to be working successfully and all encompassed a goal of institutional change among its higher education participants. Once a list of potential site-visit candidates was drafted, the MSPs were invited to participate in the CASHÉ research. The MSP principal investigator's willingness to participate and the time frame within which they were willing to allow a site visit ultimately determined the final selection of sites. The MSP's visited by CASHÉ included:

PRISM: Partnership for Reform in Science and Mathematics
University System of Georgia
MSP of Greater Philadelphia
La Salle University
FOCUS: Faculty Outreach Collaboration Uniting Scientists, Students, and Schools
University of California, Irvine
Appalachian MSP
University of Kentucky
Preparing Virginia's Mathematics Specialists
Virginia Commonwealth University
Rocky Mountain Middle School MSP
University of Colorado at Denver

An overview of the site visits to these MSP projects is appended (Appendix E).

Procedure

Each site was visited by at least three team members and sometimes as many as six team members. Teams always included at least two advisory board members and a project staff member. All visits were at least two days and included both individual and group interviews. Prior to each visit, the site visit teams held a conference call with the principal investigator(s) and project director(s) to explain the purpose of CASHÉ, to discuss topics and questions of interest, and to structure the agenda for the visit. At the completion of each site visit, participants were asked to write a synopsis of their impressions of what was learned at each site.

Questions

In order to guide site visit discussions and to maintain consistency across site visits, a set of interview questions was developed. They are relatively open ended questions and were not asked question by question, but were used to keep the interviews focused and similar in nature. The participating MSPs received the questions in advance in order to obtain a greater understanding of the purpose of the CASHÉ site visit.

The site visit questions were meant to:

- establish the history and context of the MSP;

- capture the ways in which MSP participants leveraged institutional change through the MSP;
- identify the body of evidence that supports the campus changes that are related (in whole or in part) to the MSP; and
- determine the potential for sustaining the changes initiated by the MSP beyond the funding life of the MSP.

Advisory Board Meetings

In 2005, a multidisciplinary national Advisory Board was created to provide external guidance, direction, and validation for the CASHÉ project. There were three fundamental areas of inquiry that this group was charged with helping the project staff address:

1. When we talk about change and sustainability in higher education resulting from MSP work, what should we be looking for? What is the evidence that it exists? What are the indicators? What literature/research should we be consulting?

2. What are we learning from MSP projects across the nation about what works, and what does not work, in efforts to engage higher education faculty in the improvement of STEM education across the P-20 educational system?

3. What can be done to foster, encourage, and even require policy and implementation actions by schools, universities, professional associations, and governmental agencies to improve STEM education into sustainable practice?

The Advisory Board was convened four times over the course of the CASHÉ project: September 2005, September 2006, September 2007, and November 2009. Agendas and meeting materials are attached as appendices to this report. In addition, several members of the Advisory Board served as members of site visit teams to MSP projects, described later in this report. The Advisory Board membership included:

Mel George (Chair)
President Emeritus, University of Missouri and St. Olaf College
Spencer Benson
Associate Professor, Cell Biology and Molecular Genetics, and Director of the Center for Teaching Excellence, University of Maryland College Park
Patrick Callan
President, National Center for Public Policy in Higher Education
Amy Chang
Education Director, American Society of Microbiology
Margaret Cozzens
Research Professor, Rutgers University
Penelope Earley
Professor, College of Education and Human Development, George Mason University

Russell Edgerton
Senior Fellow, Carnegie Foundation for the Advancement of Teaching
Daniel Fallon
Chair, Education Division, Carnegie Corporation of New York
Lorraine Fleming
Professor, Department of Civil Engineering, Howard University
Joy Frechtling
Vice President, WESTAT
Willis Hawley
Professor Emeritus, Department of Education Policy and Leadership, University of Maryland College Park
Bernie Khoury
Executive Officer Emeritus, American Association of Physics Teachers
William Kirwan
Chancellor, University System of Maryland
Jay Labov
Senior Advisor, Center for Education, National Research Council
Don Langenberg
Chancellor Emeritus, University System of Maryland
Jeanne Narum
Director, Project Kaleidoscope
Judith Ramaley
President, Winona State University
Eugene Rice
Scholar in Residence, Association of American Colleges and Universities
Philip Uri Treisman
Charles A. Dana Center for Science and Mathematics Education, University of Texas at Austin
Satish Tripathi
Provost and Executive Vice President for Academic Affairs, University at Buffalo
Iris Weiss
President, Horizon Research, Inc.

Knowledge Dissemination Activities

A list of knowledge dissemination activities related to CASHÉ, including presentations at national meetings, is included as Appendix F to this report.

Key Themes Related to Change and Sustainability

CASHÉ staff has attempted to synthesize the finding and observations it has made over the course of the grant into theme areas associated with change processes and outcomes among participating MSP colleges and universities. The findings and observations are drawn from the broad work undertaken by CASHÉ.

Theme 1: Backdrop of Institutional Culture/Context

- **MSP's requirement for an increased role for higher education in K-12 STEM education surfaced conflicting beliefs regarding fundamental institutional priorities.**

By design, MSP grants have fostered strong linkages between colleges and universities and K-12 schools and school districts, and have engaged faculty in high-impact activities designed to strengthen K-12 STEM education. This increase in higher education's participation in K-12-related activities, a requirement of the MSP program, has exposed campus conflicts regarding the institution's definition and understanding of its fundamental priorities. On many MSP campuses there are tensions between the goals of increasing research standing and institutional prestige and the MSP-related priorities of STEM teacher recruitment, preparation, and professional development; partnerships with K-12 schools; and undergraduate education.

- **On campus, MSPs catalyzed discussions that focused on shared responsibility for the recruitment, preparation, and professional development of K-12 STEM teachers.**

Some MSPs were successful in promoting cross-campus discussion, collaboration, and action related to core challenges associated with the recruitment, preparation, and professional development of STEM teachers. MSP projects expanded responsibility for addressing these challenges beyond the institution's college/school of education to the broader academic community, specifically to the STEM disciplines on campus. Although cross-campus communication and collaboration on aspects of K-12 STEM teaching have increased, there are indicators that institutions have lagged in efforts to promote K-12 STEM teaching as a viable and honorable career to their undergraduate STEM majors.

- **Higher education's involvement in an MSP raised awareness of education as a "closed loop" system.**

As institutions of higher education worked more closely with school districts and schools within the framework of an MSP, they more clearly understood the notion of a "closed loop" education system. Many faculty moved beyond criticizing the quality of incoming students to a realization of their role in preparing the majority of K-12 teachers who teach these students. They recognized and accepted this role and were more open to collaborating with their K-12 partners to improve P-20 teaching and learning. The MSP provided higher education institutions the needed inroads into K-12 schools and K-12 schools the needed inroads into higher education institutions. In some cases, the acceptance of P-20 as a closed loop system resulted in activities that were not originally envisioned in the MSP's scope of work. Most notably, some MSPs tackled the problem of P-20 curriculum alignment.

Theme 2: Role of MSP Project Leaders

- **The emergence and sustainability of MSP projects depended on a few key faculty leaders.**

Key faculty leaders with a pre-MSP history of collaboration both within and across institutions, and in some cases with K-12 partners, were better able to guide the emerging MSP collaboration and to address the question of the project's sustainability. Some MSP faculty leaders were seen as "academic entrepreneurs" capable of forging new relationships, creating revenue-generating programs, aggressively pursuing additional funding, and creating new organizations either inside or outside their home institution to house the work of the MSP. Many were described as "paving the way" for new faculty positions such as faculty appointments with a research focus on teaching and learning in the discipline.

- **NSF's decision to limit MSP principal investigator appointments to STEM faculty raised concerns about limiting MSP leadership capacity.**

While seeking to engage STEM faculty more fully in the work of the MSP program, NSF's decision to require a STEM faculty member as principal investigator could eliminate the most experienced and qualified academic leader with the greatest potential for developing a successful MSP from assuming the leadership role. It also could prohibit future projects from residing in a campus structure, such as cross-functional administrative unit or at a university system level, which is best suited for engaging cross-campus collaboration on MSP work. Experience shows successful MSPs were guided by key leaders from across the academic spectrum and that some of the "academic entrepreneurs" mentioned above were not STEM faculty members.

- **The MSP project has produced a community of faculty leaders from across the nation who are steeped in the knowledge and experience of MSP project work.**

There is a growing network of MSP faculty leaders who have specific expertise in doing MSP project work and who often turn to each other as peers for validation and support. One of the perceived benefits of the MSP community is that MSP leaders have frequent opportunities to convene, both face-to-face and online, in order to share evidence and best practices in a public forum. The MSP project has produced a cadre of leaders steeped in the knowledge and experience of MSP project work and accustomed to sharing that knowledge and experience with other undertaking similar projects across the nation. This cadre has the potential to support, inform, and promote MSP work at institutions of higher education not yet involved in the MSP enterprise.

Theme 3: Impact of Institutional Leadership and Support

- **Both top-down and bottom-up leadership models emerged on MSP campuses.**

Some MSPs took a bottom-up approach to initiate change, with faculty leaders working at the grassroots level to move the MSP agenda and partnership forward. In other cases, campus administrative leaders served as the activators who led the MSP charge and developed specific strategies for engaging faculty at the grassroots level.

- **Department chairs and school/college deans greatly influenced the acceptance of the MSP on campus.**

Department chairs and school/college deans were frequently mentioned as important agents – either positive or negative – in shaping the institutional climate for MSP work. Changes at this level of leadership (which occur frequently) can have a profound impact on how MSP work is viewed and valued both by the home department and by the broader campus community.

- **Faculty recognition by the institution promoted MSP participation and program sustainability.**

There was widespread acknowledgement of the importance of faculty recognition by institutional leaders for participation in an MSP without specific commitments of whether or how this work would be looked upon in promotion and tenure decisions. The recognition suggested included financial incentives, special awards, and professional acknowledgement within and beyond the campus community.

- **On campus, MSP work was more likely viewed as public service outreach rather than as a core educational mission of the institution.**

When asked, many institutional leaders drew the direct connection between the MSP work on campus and the institution's public service outreach mission fulfilled through working with K-12 schools. MSP connections to the academic enterprise or to the core educational mission of the institution were not as explicitly seen or understood.

Theme 4: Investment and Motivation of Participating Faculty

- **Many MSP faculty participants had a long-term history with K-12 outreach activities prior to the MSP project.**

Many participating faculty members already had long-term leadership and involvement in NSF-funded K-12 programs and projects similar to MSPs. Few faculty participants were encountered for whom the MSP was their first introduction to this type of work, which potentially raises questions about the challenges of bringing new faculty into MSPs and other types of P-20 activities. Many faculty members cited a personal interest or connection that originally got them involved in work related to K-12 education—children

in the public schools, a spouse or parent who was a teacher, having some K-12 teaching experience in their background.

- **Many STEM faculty come to appreciate and rely on work with K-12 as a way of being able to demonstrate "broader impact" (Criterion 2) in their NSF proposals.**

On some campuses, the MSP project was valued as a place for engaging STEM faculty in the demonstration of the "broader impact" of their NSF proposals and research. Rather than having to go out and forge new relationships and partnerships on their own, STEM faculty were able to link into a network of ongoing MSP activities, with colleagues who already had expertise and experience working with K-12 schools. The convergence of these activities suggests a unique opportunity for the institutionalization of MSP efforts.

- **There was a notable absence of tenure-track faculty participation in MSP projects.**

The ranks of the faculty involved in MSP project were primarily filled by already tenured senior faculty members and non-tenure-track faculty members, while just a few junior faculty "stars" were carefully balancing their discipline research with MSP work. This suggests that MSP involvement continues to be viewed as a risky professional endeavor for pre-tenured faculty. Campuses were at various stages in determining if there was a "career trajectory" for tenure-track faculty in STEM whose focus was on teaching and learning in the discipline.

- **Some MSPs produced outcomes related to teaching and learning on college and university campuses that were rarely addressed in the MSPs original scope of work.**

Providing support for faculty to work on undergraduate course redesign, student learning assessments, or targeted improvement of their teaching was an important "hook" for engaging faculty in MSP work, yet was rarely a part of the original design of any of the MSPs. Examples of unintended, yet welcomed outcomes included the initiation of faculty fellows programs, faculty learning communities, and professional development workshops for faculty. In more than one case, MSP-supported redesign of teacher preparation courses influenced redesign efforts in content courses in the STEM discipline. The MSP-related work undertaken on college campuses suggests the importance of differentiated faculty roles in MSP projects. Not every MSP faculty participant will be directly involved with K-12 teachers or students, some MSP faculty will labor to initiate and promote changes on campus that directly influence STEM teaching and learning in K-12 education. This suggests that K-12 STEM education reform can provide fertile soil for higher education STEM education reform.

Theme 5: Structural Changes that Supported and/or Resulted from MSP Work

- **On many campuses, MSPs created or expanded an infrastructure for targeted and sustained collaboration on STEM education between higher education, including STEM faculty, and K-12 teachers, schools, and districts.**

There was a realization that no formal mechanism existed that allowed for free and equitable communication and collaboration between STEM faculty and K-12 teachers, schools and school districts on matters related to K-12 STEM education. Without dedicated supports and structures, collaboration between these two education entities rarely happened naturally or spontaneously. Prior to the MSP program, many P-20 collaborations were forged and maintained almost exclusively by college/schools of education with little or no participation by STEM content faculty. As an outgrowth of MSP, some institutions created (or built upon existing) multi-disciplinary STEM centers or partnership outreach offices to facilitate and sustain the work of the MSP. The MSP program represents a shift in thinking about a campus's scope of responsibility in working with K-12 on matters related to STEM teaching and learning.

- **Some MSP institutions of higher education established new faculty positions to facilitate and sustain the work of their MSP.**

Institutions created "boundary spanning" faculty positions including joint faculty appointments, education appointments in STEM departments, and the reverse, STEM appointments in education departments. Some institutions intended to increase these types of appointments as institutional funding became available, as these appointments were seen as pivotal to sustaining MSP work in the long term. Such positions also served as an important entre into interdisciplinary work at the institution. MSPs have the potential to serve as a national model for learning about the support and management of interdisciplinary faculty teams, as well as for evaluating, rewarding, and advancing interdisciplinary work in higher education.

- **MSPs gave rise to a variety of learning networks that linked all P-20 MSP STEM practitioners.**

MSPs fostered the establishment and growth of formal and informal professional networks and learning communities focused on the work of MSPs. In addition to linking participants within the K-12 teaching community or connecting MSP faculty on a campus, these networks/communities reached across not only the K-12/higher education divide, but successfully connected participants in different disciplines and on different campuses.

- **Cross-campus collaboration on MSP work varied across sites and was directly related to the support of key administrative leaders.**

There was variation across MSP sites in terms of the degree of formal collaboration related to MSP work (or to the topic of teacher preparation in general) between faculty in

colleges/schools of arts and sciences and faculty in colleges/schools of education. This was often attributed to the influence and buy-in of individuals in key positions – deans and departments chairs—and to the degree of collegiality of their working relationships.

Theme 6: Course and Curricular Changes that Supported and/or Resulted from MSPs

- **MSP work drove the review of and, in some instances, significant changes in campus offerings related to the preparation and support of STEM teachers.**

New programs, new courses, and new pathways for initial teacher certification, as well as new professional develop programs for teachers are now in place on some campuses as a direct result of MSP support.

- **STEM curriculum alignment was an outgrowth of the work of some MSPs.**

In response to identified gaps in STEM achievement at key transition points, some MSPs attended to curricular alignment in STEM to combat these gaps as students transition from elementary school to middle school to high school and into higher education.

- **MSP work generated unexpected changes in STEM undergraduate courses and curricula.**

Increased numbers of STEM faculty involved in MSP work generated unexpected interest in the relationship of teaching and learning in K-12 to teaching and learning in higher education. As a result, several MSP projects initiated significant content and pedagogical changes in undergraduate STEM courses and curricula, changes not planned for in the MSPs original scope of work. Specific examples include the infusion of inquiry-based methods of instruction, collaborative learning/group-based work, more frequent classroom assessments, and undergraduate learning assistants.

Theme 7: Question of Sustainability

- **It was recognized that MSPs require a long-term investment and commitment by higher education institutions; sustainability plans of most MSPs depended on securing additional external funds.**

There was a collective realization that MSPs are not designed as "quick fixes" and that higher education involvement in K-12 requires a long-term investment that is built upon a history of collaboration and trust. The predominant institutional sustainability plan for MSP work was to secure additional external funding from NSF or an alternative funding source.

- **Higher education partners identified several categories of MSP initiatives with a high potential for sustainability beyond the initial funding period.**

There were several categories of MSP investments that MSP higher education faculty considered to be the most sustainable: reformed courses for STEM undergraduates, new academic programs for teacher preparation, new professional development courses focused on content and pedagogy, creation of STEM centers or similar campus structures to house cross-disciplinary collaboration and partnership work, joint appointments, and policy and regulatory changes such as new pathways to certification and changes in K-12 curriculum standards or assessments.

- **The key to MSP sustainability was often couched in terms of relationship-building while recognizing the challenges imposed by decreased funding over the long term.**

The person-to-person networks and relationships that had been built through the MSP were seen as the cornerstones supporting the continued commitment to the MSP work beyond the initial funding period. The investments that were made in individual participants were seen as investments in intellectual/human capital that would continue to pay out, while the new courses and programs what were initiated would increase the capacity of higher education to be responsive to the needs of K-12. At the same time, the most frequently cited challenge to sustainability was maintaining the viability of these new courses and programs without access to the same level of funding to involve teachers and faculty, especially during difficult economic times.

- **Some MSPs have been used to leverage broader reform initiatives beyond the original MSP partner institutions**.

MSPs have been parlayed into initiatives with a broader scope and higher visibility, often operating at regional or state levels. MSPs have played a role in securing Department of Labor WIRED grants, NGA STEM grants, U.S. Department of Education grants, other NSF grants, and in the creation of a stand-alone non-profit organization designed to continue and extend MSP work.

How Much "Change" and How Much "Sustainability"?

As this study unfolded, we came to appreciate an evolving dialectic between our two key areas of inquiry, change and sustainability. The factors in the MSP projects that fostered changes in courses and curricula, partnerships with public schools and innovative pathways to teacher preparation and certification came into conflict with the forces that exist on university campuses to preserve proven structures of knowledge management and dissemination such as tenure and promotion policies, college, departmental and disciplinary course policies, and academic calendar-driven programs. Under these conditions, change is predictably slow and deliberate at best. When, however, changes become institutionalized—and sustainable—becoming part of the new fabric of the university, they can have a profound impact.

Where, for example, an MSP provided the initial funding for a partnership to establish a new Master's level program for teacher certification, we recognize how one-time funding can lead to a self-sustaining partnership with a school system that generates revenue for the institution while providing high quality STEM teachers for K-12 classrooms. The "jump start" from NSF through MSP is a catalyst for sustainable change.

We looked for sustainable changes in tenure and promotion policies, but with the exception of the Georgia Board of Regents policy on "Faculty Work in the Schools," we did not encounter specific examples of newly created institutional or system-level policy changes that were designed to support, reward, or sustain faculty engagement in MSPs (or in MSP-related P-20 work). We attribute this major policy change to multiple factors, including the general education context in Georgia that has supported P-20 work over the past 20 years. MSP came along at the right time to institutionalize work that had a long track record at the University System.

Establishing the expectation and a track record for faculty who engage in the scholarship of teaching and learning and in work with K-12 schools is a pathway to sustainable changes, and needs to be supported and encouraged. The "broader impact" criterion in NSF proposals—linking research funding with education, outreach, and benefits to society—is one such means to encourage and support STEM faculty engagement. Through our MSP research, we found other examples of dedicated tenured faculty and non-tenure track faculty who were serving in a variety of unique positions, including outreach professors, discipline-based education researchers, joint appointments, and clinical faculty who worked directly with school partners. We also encountered uniquely positioned university leaders, such as Freeman Hrabowski (UMBC) and Diana Natalicio (UTAustin) who prompted us to ask the question—is long service or stability in office a necessary condition for fostering a culture of change on a campus?

Thus, while higher education institutions are structured to preserve/sustain what exists, we found many examples of a receptivity to change, given the right motivation, institutional context, and leadership. We have arrived at a set of recommendations based on our research, that we believe can be game-changers. The recommendations that follow are directed to three different audiences: The National Science Foundation: college and university leaders, and college and university faculty.

CASHÉ Recommendations

For the National Science Foundation

1. Continue to fund a variety of types of two-year and four-year colleges and universities within the NSF MSP portfolio. This will maximize the dissemination of evidence-based best practices from MSP across higher education, and demonstrates the value of the diversity of institutional types and missions. (Theme Area #1: Institutional Culture and Context)

2. Reconsider the requirement that MSP principal investigator eligibility be limited to faculty members in the STEM disciplines. Our work suggests that there are a number of different leadership models for implementing successful MSP projects on college and university campuses. (Theme Area #2: MSP Project Leaders)

3. Help MSP projects more intentionally plan for institutional commitment and sustainability on the front end of the award, by including criteria for such in the initial grant proposal and requiring a progress report to be filed with the annual project report. (Theme Area #7: Sustainability)

4. Explicitly establish expectations in future RFPs for higher education faculty to utilize the knowledge and experience gained in working in K-12 through MSP as a catalyst for curricular and pedagogical changes in undergraduate STEM courses. (Theme Area #4: Participating Faculty; Theme Area #6: Curricular Changes)

5. Strengthen NSF's commitment to the advancement of undergraduate STEM education by providing benchmarks and models for faculty research proposals to NSF that specifically address undergraduate STEM education through the "broader impact" criterion. (Theme Area #4: Participating Faculty)

6. Building on experience from MSP, develop a policy on STEM teacher preparation at NSF that positions it as a cross-campus activity involving collaboration between STEM faculty, education faculty, and K-12 educators. This will create the rational and framework for institutions that want to engage in transformative work, but need a justification and rationale. (Theme Area #7: Sustainability)

7. Promote the scholarship of teaching and learning in the STEM disciplines as an important contribution to the faculty tenure and promotion portfolio. (Theme Area #4: Participating Faculty)

8. Continue to invest in the MSP KMD infrastructure—knowledge management and dissemination—as part of NSF's mission around STEM teaching and learning. In particular, partner with other federal agencies, discipline societies, and accrediting organizations to move the conversation to the highest levels of leadership and to the broader community, including higher education institutions and K-12 school systems not participating in the MSP program. (Theme Area #7: Sustainability)

For College and University Leaders

9. It is important for colleges and universities to examine their core strengths before committing to an MSP project. MSPs should align with institutions that envision themselves first and foremost as leaders in undergraduate education with a strong commitment to K-12 education. If an institution seeks to be something else, then an MSP may not be best situated there. (Theme Area #1: Institutional Culture/Context)

10. Because the visibility and recognition that they give to their MSP and participating faculty make a difference, presidents, provosts, and deans should make a concerted effort to know more about this work and to publicly recognize those faculty involved in it. They should publicize faculty work with K-12 schools as valuable in its own right, as well as being important in increasing the success of other NSF funding proposals by demonstrating broader impact. (Theme Area #3: Institutional Leadership and Support)

11. Institutional leaders should ensure that STEM teaching and learning is a priority in the institutional strategic plan in order to value and prioritize such initiatives as MSP, as well as to expand the campus's responsibility for preparing K-12 teachers and supporting K-12 education beyond colleges/schools of education. (Theme Area #3: Institutional Leadership and Support; Theme Area #5: Structural Changes)

12. Institutional leaders should know that their leadership in facilitating cross-disciplinary collaboration (e.g., between education and arts & sciences) around MSP and related STEM teaching and learning priorities is important. This may involve elevation to a campus-level group or structure (e.g., committee, center, etc.) in order for such collaboration to be sustained over time. (Theme Area #3: Institutional Leadership and Support; Theme Area #5: Structural Changes)

For Higher Education Faculty

13. With well-respected, well-established STEM leaders taking the lead and serving as role models, faculty and professional societies should establish mechanisms to support P-20 education that are comparable to practices and policies inherent in the research enterprise. (Theme Area #4: Participating Faculty)

14. Create opportunities for career advancement and expanded leadership capacity among non tenure-track faculty, adjunct faculty, and non-faculty academic administrators who are proactively working with MSP and related areas of STEM teaching and learning. (Theme Area #4: Participating Faculty)

15. In departmental and institutional self-studies, document how work with K-12 teachers and schools through MSP has implications for pedagogical improvements in undergraduate education. (Theme Area #4: Participating Faculty; Theme Area #6: Curricular Changes)

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