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Placing the MSP Program's Institute Partnerships in a Career Development Context

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Exhibits

PREFACE

This study is one in a series of substudies for the Math and Science Partnership Program Evaluation (MSP-PE), conducted for the National Science Foundation's Math and Science Partnership Program (NSF-MSP). The MSP-PE is conducted under Contract No. EHR-0456995. Since 2007, Bernice Anderson, Ed.D., Senior Advisor for Evaluation, Directorate for Education and Human Resources, has served as the NSF Program Officer. The author is Darnella Davis, Ed.D., of COSMOS Corporation. Kelsey Van Dyke (COSMOS) provided research assistance.

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Placing the MSP Program's Institute Partnerships in a Career Development Context

Through a variety of initiatives over the years, the National Science Foundation has supported the development of promising approaches to improving science, technology, engineering, and mathematics (STEM) education. With the first Math and Science Partnership (MSP) Program solicitation inviting proposals to launch "Teacher Institutes for the 21st Century" (Institute Partnerships), NSF elaborated the role of summer training opportunities in promoting improvements to STEM education. This study examined the characteristics of eight Institute Partnerships funded in 2003 and 2004 under the provisions of the MSP Program's "Teacher Institutes for the 21st Century." A more concise statement of the direction that Institute Partnerships may follow is contained in the 2008 solicitation:

> *"Institute Partnerships are designed especially to meet national needs for teachers who have deep knowledge of disciplinary content and are school-based intellectual leaders in mathematics and science"* (NSF 08-525).

This study drew on data from site visits conducted by the Math and Science Partnership Program Evaluation (MSP-PE) in 2007 and 2008; the MSPs' own annual and evaluators' reports; and data collected through the MSP-Management Information System (MSP-MIS). The Institutes Partnerships' activities are ongoing. They include traditional and new strategies to recruit, train, and retain teachers prepared to take leadership roles in their classes, schools, and districts. This commitment signals an investment in career development within a specific context and not just a single professional training opportunity. Still, this review is only a snapshot of the Institute Partnerships up to and including data available as of November 2008.

A. Continuous Learning for Science and Mathematics Educators

Transforming Professional Development

The National Science Foundation (NSF) has long understood the benefits of continuous training among teachers engaged in science, technology, engineering, and mathematics (STEM) education. Dating from the 1950s and the space race, NSF has developed leading-edge initiatives to help the nation's mathematics and science teachers attain global stature as education professionals.

NSF's Earlier Support of Summer Institutes. Beginning in 1954, NSF supported efforts to improve secondary school science and mathematics teaching through Summer Institutes. The Summer Institutes offered professional development based on the assumption, "that better trained teachers could, through better trained students, raise the nation's literacy and manpower in science and mathematics" (Krieghbaum and Rawson, 1969, pp. 3-4). The Summer Institutes also assumed that summer subject-matter training would address the need to update teachers' knowledge approximately every five years, especially following the scientific advances concurrent with World War II, as well as provide basic information for those teaching out-of-field.

NSF's mid-century effort spawned a variety of Summer Institutes that ranged from remedial to graduate levels in the coverage of STEM content. The Summer Institutes varied in sessions lasting from four to 12 weeks, with some courses of study extending into academic year follow-up seminars or multi-year programs leading to advanced degrees.

While the NSF Summer Institutes updated secondary teachers in a subject-matter field, they also brought about, "a change in attitude toward elementary and secondary instruction found among university staffs..." (Krieghbaum and Rawson, 1969, p. 11). The benefits of engaging university faculty in shaping the content of the Summer Institutes was expressed by one participant who observed, "the situation in science today is so complex that an improvement in basic instruction can only be made by means of collaboration between teachers and university staff" (Krieghbaum and Rawson, 1969, p. 11).

Unfortunately, the voluntary nature of the NSF Summer Institutes could do little to engage many of the teachers who likely needed them most, leaving the Senate Committee on Labor and Welfare to recommend that NSF place funds, "wherever facilities and manpower offered the greatest hope of success" (Krieghbaum and Rawson, 1969, p. 12). As an additional criterion, other things being equal, NSF gave preference to funding geographically underrepresented areas.

After a decade of support, NSF engaged an evaluation team to weigh the merits of its investment in Summer Institutes. Among a number of challenges highlighted in that evaluation was the endless number of teachers that needed updating (or to a lesser extent the acquisition) of basic mathematics or science skills. Another challenge was the need to minimize costs by incorporating training programs into ongoing IHE (institutions of higher education) programs (Krieghbaum and Rawson, 1969).

Updating the Structure of Professional Development. Before examining NSF's support of the MSP Program's Institute Partnerships[1], it will be helpful to frame the present analysis by highlighting a number of issues arising in the debate over how to structure professional development. The debate is strongly influenced by concerns with teacher quality.

Kennedy (2008) and Wayne, Yoon, Zhu, Cronen, and Garet (2008), note a consensus on the key elements needed to develop qualified teachers but criticize the lack of research that would justify collective agreement. While Kennedy discusses the research basis for shaping teacher education programs, Wayne et al. focus on the role of research in guiding *investments* in teacher professional development. These authors call for a more critical

[1] MSP Program's Institutes are referred to as "Institute Partnerships" or simply "Institutes." A lower case "i" is used when referring to training institutes in general.

examination of evidence leading to claims of increased teacher quality. These considerations should be noted in any discussion of professional development strategies or designs.

The sections below discuss the progression of thinking about professional development, first as part of a reform agenda, then in efforts to bring training to the school or classroom, followed by an examination of more recent attempts to empower sufficient numbers of teachers capable of improving STEM education.

Elements of Reform. The paradigm shift in training teachers can be traced to concerns about the poor state of education chronicled in *A Nation at Risk* (National Commission on Excellence in Education, 1983) and subsequent debates over the most effective ways to improve teaching and learning. An MSP-PE study (Moyer-Packenham, Bolyard, Oh, and Irby, 2009) distinguishes between traditional and reform types of professional development, with the latter including lesson study, peer or content coaching, mentoring, teacher research, and professional learning communities. Although the authors note a growing consensus in the field about what constitutes high quality professional development, they also point out the relative paucity of research on the relationship between characteristics of professional development and improved mathematics and science teaching.

Moyer-Packenham et al. (2009) frame their analysis of professional development in terms of *structural* features (form, duration, and collective participation) and *core* features (content, coherence, and active learning) of professional development. They cite Garet, Porter, Desimone, Birman, and Yoon (2001) as showing that these features have significant positive effects on teacher knowledge and practice. However, in developing a master's degree program in chemistry education, Blaise, Milne, and Dai (2001) describe how discipline faculty came to realize that in their professional development efforts they needed not just to cover content but to see teaching and learning as inseparable. They found that working collaboratively was an essential feature of the inquiry-based instructional approach they embraced and that research had shown to yield the most positive learning outcomes.

Spillane (2005) echoes these convictions in calling for a more sophisticated construction of teaching, albeit one that takes subject matter into account.

The need for continuous professional development within science and mathematics is grounded in the recognition that the knowledge base for teaching these subjects is growing, partly because scientific research is advancing (Banilower, Cohen, Pasley, and Weiss, 2008; Loucks-Horsley, Love, Stiles, Mundry, and Hewson, 2003). In the last decade, career development for mathematics and science teachers also has received increased attention as the shortage of, and increased need for, educators for these disciplines captures public attention (Bolyard and Moyer-Packenham, 2008; National Academy of Sciences, 2007).

Writing in 1990, Friend and Cook argued that master or lead teachers can play a vital role in leveraging the needed subject-specific content and pedagogy to keep other STEM classroom teachers up to date. While they acknowledged the bewildering array of reforms tendered in response to the need for improvements in STEM teaching, they saw promise in *professionalism* and *empowerment* through *collaboration*. They defined collaboration as: "…a style for interaction between at least two co-equal parties voluntarily engaged in shared decision-making as they work toward a common goal" (p. 72). The authors asserted that the ability of practitioners to collaborate is integral to school change. For them,

> *…teachers pursuing professional development are encouraged to enhance their knowledge and skill through collaborative staff activities such as peer coaching and peer supervision while staff developers are advised to ensure local teacher participation in designing and delivering staff development programs* (p. 71).

In contrast, Tschannen-Moran (2001), argued that inherent in the notion of lead teachers is a contradiction in that hierarchical arrangements can upset the balance of teacher status and thereby threaten the parity and trust required for true collaboration.

Likewise, empowerment or the autonomy of teachers to shape practice to fit the needs of their respective classrooms may run counter to reform initiatives. Friend and Cook (1990) argued that these tensions are most evident when legislated mandates undermine teachers' judgments about the best basis on which to make educational decisions (p. 78). Echoing this perspective, Louis and Marks (1998), asserted that tensions exist among: 1) state and national reformers driving reform through the elaboration of standards and accountability systems; 2) school systems whose capacity for reform is defined in relation to its level of decentralization; and, 3) colleges of education in reexamining "the role of individual teachers as intellectuals and as critical actors both within and outside the classroom" (p. 561).

These authors are in agreement that beyond content and pedagogy, teachers should acquire the skills to make their own decisions as well as to engage in collaborations. Similarly, they stress that administrators should receive parallel training because they play such a critical role in facilitating change. Louis and Marks (1998) note that schools and teachers will need help in the form of external experts as well as structures to support "openness, trust, genuine reflection, and collaboration focused on student learning…" (p. 561).

Sergiovanni (1992) also tackled tensions inherent in notions of leadership and professionalism. For him, the arguments center on the concepts of schools as formal organizations with hierarchical layers of power versus schools as communities of learning where all members collaborate and contribute according to their respective talents (also see Spillane, 2004, for a discussion of reciprocal interdependencies). Sergiovanni also shares concerns over the motivations that drive teachers to work towards a shared vision including common values and trust.

Citing the transformation of a Los Angeles school from a formal organization to a learning community, Sergiovanni notes that professionalism and leadership are in some ways antithetical. "The more professionalism is emphasized, the less leadership is needed.

The more leadership is emphasized the less likely it is that professionalism will develop" (p. 42). By extension, the author saw reform only where teachers become professionals who embody *competence plus virtue*, that is:

- A commitment to practice in an exemplary way;
- A commitment to practice toward valued social ends;
- A commitment not only to one's own practice but to the practice itself; and
- A commitment to the ethic of caring (p. 43).

Under this definition, teachers accept responsibility for their own professional growth or "shaping their own learning experiences" (Thibodeau, 2008, p. 63), but also transform their practices from the individual to the collective, thereby defining success not by what happens in *their* classrooms but within the education community as a whole. Similarly, Elmore (2003) described "internal accountability" for a given school as a coherence around expectations for student learning and the means to influence instructional practice in ways that impact student performance (p. 9). The importance of relationships between greater responsibility and commitment is supported by research that suggests that teachers engaged in contributing to the development of challenging courses are more highly motivated to improve instruction (Moyer-Packenham et al, 2009).

The Move Towards Job-Embedded Learning. A dimension implicit in these professional development models is practice-based professional learning, often referred to as job-embedded professional development. Job-embedded professional development is reportedly linked to positive changes in teacher practices, higher expectations for students, willingness to use innovative materials and methods, and improved student achievement (Louis and Marks, 1998; Thibodeau, 2008).[2] It stands in contrast to earlier off-site training

[2] See Cavalluzzo (2004) for a study providing evidence of the link between *professional qualifications* and student achievement, and Waters, Marzano, and McNulty (2003) for research on the link between *leadership* and student achievement.

that stressed content knowledge acquisition, giving scant attention to local implementation constraints.

Echoing the limitations of off-site trainings, DuFour (2004) notes the artificial distinction between working and learning for teachers. Underscoring the benefits of drawing on a given school or district's collective capacity, DuFour acknowledges that a collaborative culture needs to be well structured, requiring teachers to work together but ensuring that they have the time and support to do so. Loucks-Horsley, Love, Stiles, Mundry, and Hewson (2003) assert that providing training to one teacher at a time disregards the importance of context and increases the difficulty of scaling up or leveraging professional development.

In standards for quality professional development crafted by the National Staff Development Council (NSDC), the focus of job-embedded learning communities, which include teachers, principals, central office staff, superintendents, and school board members, is on improving student achievement. In their discussion of the NSDC standards, Roy and Hord (2004) concur that individuals must adapt or modify the components of new practices as they implement them, thus echoing both DuFour (2004) and Friend and Cook (1990). Roy and Hord write that staff development is a *shared responsibility*.

Distributing Leadership. Recent efforts address the need to prepare lead or master teachers for distributed leadership roles, marking a paradigm shift towards training designed with a supportive education team in mind (Spillane, 2002). These considerations converge in notions of distributed leadership. The Institute for Learning (IFL), an arm of the Learning Research and Development Center (LRDC) at the University of Pittsburgh, is testing a theory of action that measures the relationships among principal, teacher, and student behavior and performance with the intention of developing more effective training (Quint, Akey, Rappaport, and Wilner, 2007). The research suggests that interactions among administrators and teachers around professional development, including training for principals, can positively influence school-level performance.

As one group noted, “teaching is the new frontier in the struggle to improve schools” and current professional development may not be appropriate or “provide enough support to enable teachers to apply what they learn” (Loucks-Horsley et al., 2003; also see Marzano, 2000, p. xvii). Spillane and Camburn (2006) suggest that support for teachers is not hierarchical. Instead, “The practice aspect of the distributed framework…sees leadership *practice* as a product of the interactions of school *leaders*, *followers*, and their *situations*” (p. 7). For Darling-Hammond (1998), “Creating a web of always-available supports for students’ and teachers’ learning is the difficult, unglamorous, but absolutely essential work that will make the difference for school reform” (p. 294). Increasingly attention is being given to the challenges of devoting time and resources to creating professional learning communities, study groups, team or peer teaching opportunities, or other job-embedded collaborative learning initiatives (Thompson, Gregg, and Niska, 2004).

One aspect of facilitating the implementation of the knowledge and skills gained in career training opportunities is the attempt to reach a *critical mass* of STEM teachers at the local level. Given the relative shortages of qualified STEM teachers, developing supportive networks to extend the reach of individuals’ training is a means of keeping pace with the attrition often wrought by higher-paying alternative STEM careers, the trickle of new teachers, and the retirement of educators drawn to STEM teaching under less demanding circumstances (Burke and Cavalluzzo, 2004a).

Another aspect of designing professional development that can maximize impact is calculating the dosage needed to update or upgrade teacher knowledge or skills. Intuitively, dosage would be driven by the collective state of teacher capacity in any given educational system and the resources available for providing the needed training.[3] Yet this relationship is often neglected or glossed over in optimistic plans that are later shelved in the face of unanticipated costs (Davis, 2008).

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[3] Bolyard and Moyer-Packenham (2008), note that the Conference Board of Mathematical Sciences recommends specific quantities of coursework for teachers by level, with high school courses being the equivalent of those for an undergraduate major, but stressing that the courses be relevant to the mathematics that the teachers will teach.

Nonetheless, professional development trends appear to increasingly link the effectiveness of offerings or opportunities to the contexts in which the knowledge and skills will be applied (Thibodeau, 2008). Further, career development opportunities especially within the STEM fields must address the challenge of operationalizing individual training designed to serve as a catalyst for transforming the learning community. Planners must detail the steps in transferring learning to others in the field when “responsibilities of education leaders now exceed what individual administrators in schools and districts can be expected to carry out alone” (Sanders and Kearney, 2008, p.1). Indeed, greater awareness of these constraints may contribute to revised definitions of educational leadership, teacher quality, or the long-term development of an individual’s career. Thus placing career development in context means: 1) attending to the embedded learning environment, 2) acknowledging the investments required to support individuals in becoming master teachers with a commitment to their local communities, and 3) accepting that off-site training must lead to locally adapted implementation.

Building Teacher Leaders within the MSP Program

Within the MSP Program, Institute Partnerships have a special charge to develop math and science teachers as school- and district-based intellectual leaders and master teachers. Other types of MSP Program awards have different foci: comprehensive MSPs seek to implement change in both math and science and across the K-12 continuum, while targeted MSPs focus on a narrower grade range or disciplinary focus (e.g., elementary science or the introduction of algebra in grade 8).[4]

All of these types of MSP awardees are encouraged to engage in research and development as they generate and test new ideas in mathematics and science education.

[4] Research, Evaluation, and Technical Assistance (RETA) awards are charged with building and enhancing large-scale research capacity for all of the other MSP awardees. They may carry out cross-MSP activities, including research-oriented studies and technical assistance.

However, the bulk of the MSP Program's efforts rely on improving the quality of teaching and learning through enhanced professional development designed to increase teacher quality. Thus, comprehensive or targeted MSP awards also may generate teacher leaders.

Enhancing the Quality of STEM Teacher Leaders. NSF's conviction that improvements in the quality of STEM teaching will lead to improved student achievement has been borne out by a growing body of research. In an MSP-PE study, Bolyard and Moyer-Packenham (2008) review the literature on teacher quality with a particular focus on mathematics and science. Their review noted that differences in teacher quality may explain more of the variance in student achievement than any other school-based factor. Yet while a number of policy instruments, from government legislation to professional organization standards, provide teacher quality definitions in terms of appropriate training, certification, and experience, there is some concern over how readily these definitions lead to enhanced teaching.

For example, the National Board for Professional Teaching Standards asserts that accomplished teaching is based on standards and five propositions; specifically, that teachers:

1) Are committed to students' learning;
2) Know the content of their subject as well as how to teach it;
3) Carefully monitor students' learning;
4) Reflect on their practices; and
5) Are members of professional learning communities.

The challenge is to find appropriate measures for these objectives because these definitions go hand-in-hand with increased interest in identifying the characteristics that determine quality in mathematics and science teachers (Bolyard and Moyer-Packenham, 2008). Through the MSP Program, NSF is encouraging partnerships among K-12 districts and IHEs, including STEM faculty, that draw on research evidence to achieve more accomplished teaching.

In looking at measures of teacher quality among the MSPs, Moyer-Packenham, Bolyard, Kitsantas, and Oh (2008) note that partnerships tended to focus on teacher practices and beliefs, subject knowledge, and pedagogical knowledge. This focus contrasts with more general measures of teacher quality that focus on years of experience, general ability, and certification. The MSPs' focus makes sense in terms of NSF's programmatic objectives because, according to the authors, the MSPs' foci are more closely associated with student achievement outcomes (p. 587). Yet the more general teacher quality measures may be more closely associated with characteristics of the kinds of *teacher leaders* being supported by the Institute Partnerships.

In Bolyard and Moyer-Packenham's (2008) review of research on teacher quality, there was evidence of positive relationships between teaching experience and students' mathematics and science achievements, even though results were more consistent for mathematics and at the secondary level (p. 517; also see Hill, Rowan, and Ball, 2005). These findings highlight the role of lead teachers and the characteristics that indicate their ability to master and appropriately apply "pedagogical content knowledge"[5] (Schulman quoted in Bolyard and Moyer-Packenham, 2008, p. 522). This *knowing what to do* and *when to do it* is a sign of professionalism as discussed above.

The goal of building leadership skills marks the more recent trend in providing training with a supportive education team or network in mind. Shifts in the language of NSF's three solicitations aimed at Institute Partnerships appear to reflect this move towards professionalism while maximizing its diffusion in support of the kind of community of learners championed by Sergiovanni (1992) and Friend and Cook (1990).

Teacher Institutes for the 21st Century. Introduced in a 2003 solicitation, NSF's 21st Century Institutes build on the legacy of NSF's earlier Summer Institutes but tackle a

[5] Ball, Thames, and Phelps (2008) show that pedagogical content knowledge is now understood to be a more complex concept, while Hill, Ball, and Shilling (2008) have developed measures designed to unpack the distinct elements contained within pedagogical content knowledge.

more complex array of challenges. The Institute Partnerships are to focus on further leveraging the acquisition of content knowledge and pedagogy. Specifically, the Institutes' goals include the following:

- Renew experienced classroom teacher interest in and enthusiasm for their discipline;
- Deepen subject knowledge;
- Build leadership skills; and
- Deploy lead or master teachers to serve as:
    - Catalysts for mathematics and science reform within schools;
    - Resources for peers; and
    - Contributors in developing challenging or advanced courses.

Among these objectives, the focus on experienced classroom teachers who are motivated to further deepen their subject knowledge presents an opportunity to move toward a professionalization of teaching akin to National Board certification, which may serve as an effective indicator of teacher quality (Burke and Cavalluzzo, 2004b; Cavalluzzo 2004). This emphasis on teachers' professionalization or career enhancement stands in contrast to earlier Summer Institutes, which focused more on improving individual competence and less on the catalytic role that the trainee might effect through local implementation. Now, the trainee's prior knowledge as well as his or her stature within a pool of potential participants marks a shift in selection recruitment procedures.

In serving as catalysts for mathematics and science reform within their schools, Institute Partnership participants may address the issue of *scale* (Loucks-Horsley, et al., 2003), but also *cost* in recognizing budgetary constraints on meeting the professional development needs of all educators engaged in science and mathematics teaching and learning. This stance is evidenced in the title of one Institute's course for administrators:

Distributed Leadership: Leveraging Leadership and Learning (46).[6] The Institutes therefore must meet high expectations for maximizing impacts while also emphasizing continuous learning.

The Role of the MSP Program's Institutes in Building Capacity Among IHE and K-12 Partners. The broad goals for generating a cadre of master teachers in mathematics and science education were laid out in the first solicitation covering Institute awards, NSF 03-605. These broad goals serve to articulate the research questions that guide the current review. Based on the MSP Program's Institute Partnership objectives, the first concern is with finding evidence that participants have a deep understanding of mathematics or science that enables them to lead others. The second concern is examining how the Institutes enable teachers to become educational leaders.

From their inception, like other MSP types, Institutes were challenged to identify networks for working effectively with districts, other IHEs, national disciplinary or professional societies, or community partners. However, to address the need to maximize impacts and leverage individual training within a cascading or networked local system, Institutes had to pay particular attention to recruiting, training, retaining, and deploying teacher leaders and master mathematics and science teachers (see Burke and Cavalluzzo, 2004a). That is, to meet the commitment to weeks-long summer training, Institutes were challenged to take special care in selecting participants, developing appropriate subject curriculum, aligning courses of study (compatible with district reforms), refining dosage, creating flexible scheduling, and providing supportive incentives (Hansen, Lien, Cavalluzzo, and Wenger, 2004). The Institute Partnerships also were charged with addressing the research and development focus of the MSP Program by researching and utilizing model strategies and practices, using evidence-based approaches, and testing innovative practices.

[6] In order to maintain the MSPs' anonymity, each MSP is identified by an arbitrarily assigned number. The numbers appear in parentheses to denote the individual MSP(s) from which relevant data derive from proposals, annual or evaluator's reports, the MSP-MIS, or MSP-PE's site visit notes.

In its 2003 solicitation, NSF indicated that Institute alumni, "should no longer see themselves as isolated individuals but rather as members of a professional community, linked with others devoted to learning and practice" (NSF 03-605). In one study of schools participating in the MSP Program, Martinez, Firestone, and Polovsky (2005) credit the successful improvements at one school to the fact that,

> *Not only did the principal share the power he had, but also encouraged teachers to participate in power relations...We suspect that this empowerment came from the fact that leadership was distributed in a way that all leaders had meaningful tasks and there was a strong agreement on the agenda* (p. 17).

One meaningful task that signals empowerment is seen in teachers' contributions to the development of challenging courses. The current study therefore examined evidence of such efforts among Institute participants.

While Martinez, Firestone, and Polovsky (2005) caution that alignment and micropolitics, in addition to leadership tasks, are dimensions of distributed leadership that require further study (p. 39), some aspects of empowerment may be more easily traced. Within the Institute Partnerships, empowerment and leadership may be discerned through efforts that extend individual participants' circle of influence. Thus, following the MSP Program's objectives, the study team sought data about Institutes' efforts to engage *all* students and to grow the involvement of STEM faculty.

NSF's MSP Program differs from prior math and science partnerships, going beyond the objective of improvements in K-12 student achievement by emphasizing the engagement of IHEs' discipline-based faculty and departments. Such engagement is especially important because of the discipline faculty's expertise and the continued advances in science mentioned above.

In sum, the leadership development process ideally ensures that teachers have the mastery of content and the skills to become leaders within their respective schools or districts, are able to identify the need for and design courses that can engage all students, while working constructively with others, including STEM faculty.

B. Methodology

The historical context of professional development suggests a framework for examining Institute Partnership activities. Specifically, the research reviewed above indicates that more traditional modes of delivering training to individuals—without regard to the need for, or alignment with, local conditions, much less the achievement of clear career milestones—has limited effectiveness. While more innovative programs have not been adequately researched, alternative approaches to supporting the career development of STEM teacher leaders may be contrasted with those less anchored in the professionalization or career development process. Those programs that neglect these features may well contribute to teacher frustration, turnover, and attrition.

In this context, the term "career development" is preferred over "professional development" in connoting the deeper level of commitment required of Institute Partnerships' participants. The former term carries a notion of active pursuit, or a progression, toward greater responsibility. The latter term denotes the attainment of competence or adequacy such as fulfilling service requirements. The deeper commitment inferred in a career as a master or lead teacher is reflected in the five research questions addressed by the current study. Exhibit 1 shows the questions and how they derive from text appearing in the initial NSF Institute Partnership solicitation (all exhibits can be found at the end of the text). The answers to these questions provide a view of the role of Institute Partnerships in more clearly defining career development for STEM teacher leaders.

Data Sources

The review of the eight MSP Institute Partnerships funded in 2003 and 2004 is based on an analysis of qualitative and quantitative data contained in the MSP-PE's site visit notes, the Institute Partnerships' annual and evaluators' reports, the MSP-MIS, and posted online at MSPnet (www.MSPnet.org). The data covered the characteristics, nature and extent of activities, and the assessments used to measure progress among the Institutes. The context for the findings included the programmatic objectives of leveraging needed STEM expertise through the cultivation of partnerships among schools, districts, IHEs, and other stakeholders.

These partnerships seek to further relationships that often are based on the interests of individual disciplinary faculty or prior collaborations between partners within the same geographical regions that have shared mutual ambitions for improving the PreK-20 education continuum. Therefore, each Institute has a distinctive way of renewing teachers' enthusiasm, deepening content knowledge, building leadership, and supporting teachers in stimulating improvements to STEM education. Thus, data on the distinctive nature of each Institute's collaborative activities was of particular interest.

The Current Study's Specific Focus

The findings discussed below do not cover all aspects of Institute Partnerships' activities. For example, although about half of the eight Institutes under study were engaged in formal research projects, contributions to educational research among Institute Partnerships are addressed in a separate MSP-PE substudy on research and innovations (Davis and Yin, 2009). Similarly, partnerships, the role of IHE faculty, student achievement, and specific features of professional development among MSPs are covered in other MSP-PE substudies. Therefore, these topics have received only brief mention here.

C. Findings

Progress in Attaining the Distinctive Objectives of the MSP Program's Institute Partnerships

A profile of the Institute Partnerships is seen in their collective characteristics. Six of the current study's eight Institutes have focused primarily on mathematics while only two have concentrated on science. Like the early Summer Institutes, the 21st Century Institutes target the secondary level but have expanded, with three Institutes targeting grades K-4. In addition, the Institute Partnerships offered structured follow-up activities during the academic year (even if only online). Exhibit 2 provides an overview of the characteristics of the eight Institutes under review, showing the range of targeted grade levels, number of partners, and training schedules. The findings are now discussed according to the study's five research questions.

1. Is there evidence that the Institutes' courses of study have provided teachers with a deeper understanding of mathematics and science content? The importance of ensuring that teachers of science and mathematics possess the content knowledge to serve as catalysts within their respective educational systems is at the heart of NSF's vision for 21st Century Institutes. More than half of the Institutes have devoted considerable effort to developing challenging courses and curricula while others are employing existing course content in training sessions (44, 45, 46, 47, and 48).

The Institutes have employed a variety of data collection measures, including surveys, exams, observations, and other assessments to monitor gains in teacher content knowledge. Exhibit 3 presents evidence of these gains for each of the Institute Partnerships. All Institute Partnerships reported progress in increasing teacher content knowledge. At the same time, the rigor of the instruments and subsequently the robustness of the results varied.

The distinctive nature of deepening content knowledge among Institute participants during intensive summer training sessions was expressed by one Institute: the “summer session functions as a springboard to *the real center of…activities*: i.e., the events and activities that occur during the school year at each site project” [emphasis added] (42). In this respect, teacher content knowledge gains need to be interpreted in light of the already “experienced teachers” recruited into the Institutes and the greater emphasis placed on their ability to apply what they have learned at the school- or district-level to maximize its impact.

Ball (2003), points out that subject matter preparation or the acquisition of content knowledge is only positive if it helps teachers teach (cited in Bolyard and Moyer-Packenham, 2008, p. 528). Therefore, not to be overlooked are the Institutes’ efforts to encourage mastery of data analysis and use in guiding instruction. At least two Institutes have engaged participants in action research projects designed to familiarize them with interpreting and utilizing student achievement data for collaborative planning and decision making (48 and 49).

2. What support have Institute Partnerships provided to enable teachers to become school- or district-based leaders? There are at least three phases associated with enabling Institute-trained teachers to become mathematics and science leaders: 1) recruitment, 2) training, and 3) facilitating learning communities. These three phases are discussed below. Collectively, they lead to considerations of teacher empowerment which also are addressed.

Recruiting and Retaining Experienced Teachers. A variety of recruitment efforts were evident among the Institute Partnerships, with some strategies shifting from nominations from administrators among participating schools to an increase in the number of targeted schools in order to increase the pool of participants.[7] In one case, saturation appears to have been reached for teachers with a somewhat narrow focus in science (46).

[7] Although regular classroom teachers take part in some Institute training, the focus here is on those following a teacher leader track. For example, one Institute counts 100 teachers as participants each summer, but notes that those from non-MSP schools pay their own way (46).

Exhibit 4 shows a wide range of Institute Partnerships' criteria for selecting "experienced" teachers, while Exhibit 5 contains available information (though incomplete) on recruitment and retention patterns among the Institutes.[8] Inconsistency within the recruitment and retention data precludes even tentative analysis at this stage. Exhibit 6 provides the demographic characteristics of teachers in schools participating in the Institutes.[9] These characteristics appear to typify the disparities between teachers and higher risk students. The disparities may constrain efforts to engage teachers that are representative of the diverse populations they serve.[10]

Apart from efforts to work with district administrators in selecting "the strongest" teachers or those showing leadership potential, the Institute Partnerships have provided little information on innovative recruitment strategies or approaches for engaging teachers who are more representative of diverse student populations.

Leadership Training. To master the needed content and pedagogy to become teacher leaders, Institute participants may be required to achieve higher levels of knowledge and skills in order to guide others. The courses of study followed by the relatively small cohorts of Institute participants tended to be highly structured with most participants taking the same courses. Only two Institutes offered a limited menu of optional courses and the number of degree choices was generally not more than two. For the most part, Institute programs have not readily fallen into typical categories of preservice or inservice because participants were already teachers who were seeking to become leaders and not simply

[8] Early student achievement data for one Institute recruiting the "strongest" teachers showed no differences between students of those teachers and those of non-participants (49).

[9] Caution in interpreting data identifying participants as science or mathematics teachers is warranted in cases involving elementary school teachers who may be double counted or not identified in either category.

[10] Interestingly, a larger number of students is potentially reached through Institute activities compared with those for comprehensive and targeted MSPs (222,654 compared with 59,669 respectively in 2005-06). Comparable MSP-MIS data for comprehensive and targeted MSPs are from Table D.4.7 (Hershey-Arista et al., 2007, not shown).

fulfilling inservice requirements.[11] Many participants were working to achieve an advanced degree such as a master's in science education or a master's in middle school education with a minor in mathematics. At least half of the eight Institute Partnerships under study have provided credit through the relevant discipline department rather than through a department or school of education.[12] Five of the eight Institute Partnerships have offered courses devoted at least in part to leadership training.

One Institute's goal is to determine the extent to which the quality of the Summer Institutes results in transforming the participating classroom teachers into mathematics specialists who infuse their schools with a stronger commitment to mathematics and science excellence (44). At another Institute, participants have been working to formalize their roles by gaining certification as master mathematics teachers (43). In deploying lead teachers, yet another Institute's participants have followed a fairly traditional leadership path of modeling and co-teaching lessons, and sharing knowledge and materials with peers, curriculum specialists, and administrators (47). Yet even in this context, staff noted that "school teams are most likely to result in better opportunities for leadership." This Institute plans to encourage the participation of individuals capable of building school-levels teams. A fourth Institute reported an effort to ramp up its teacher leadership activities in response to a critical evaluation review of its efforts on this objective (46).

Aggregated data from the MSP-MIS provide some indication of the kinds of training that Institute Partnerships are offering in efforts to build leadership. MSP-MIS data indicated that, for 2005-06, Institutes gave the greatest attention to building depth in mathematics or science (100 percent), followed by developing leadership skills and implementing research-based teaching methods (each 87.5 percent and both down from 100 percent in 2004-05) (Hershey-Arista, 2007, Table E.3.4.). These results were borne out in

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[11] An exception is seen in one Institute which views its partnerships with community colleges as a means of feeding a preservice pipeline, as well as reaching a more diverse population of potential teachers (49).

[12] One Institute reports that its courses are robust enough for participants to readily transfer their credits to other institutions, if needed (43).

lists of Institute Partnerships' course offerings, which show a preponderance of content courses, followed by courses such as "Teaching and Learning Middle School Science," and finally by courses on leadership or diversity. A sampling of course titles (see the list below for examples from each Institute that listed courses) underscores the emphasis on content mastery and attempts to integrate content and pedagogy:

- Some Questions and Problems in Arithmetic;
- Problem Solving: Combinatorics;
- Problems and Issues in Mathematics Education: Leadership I for Mathematics Specialists;
- Environmental Chemistry;
- Math for Integrated Science;
- Conceptual Distinctions: The Case of Heat and Temperature;
- Teacher as Scholarly Practitioner;
- Concepts of Calculus for Middle Level Teachers; and
- Data Analysis and Probability.

Data suggest that Institutes were viewing the mastery of content and pedagogy as a means of extending the reach of lead teachers who will in turn support further learning at the school level. Exhibit 7 shows that Institute Partnerships' approaches to building leadership have been aimed at different levels and configurations of educators among participating partners.

Bolstering Learning Communities. More complex is the charge of creating or bolstering learning communities as a consequence of participating in Institute activities. Exhibit 7 provides insights into the linkages among efforts to scaffold reforms through training not just for teachers but for the administrators whose support is critical, as well as among STEM and education faculty whose interchanges with K-12 educators serve as conduits for change among partnering IHEs. Where these linkages are formally structured, learning communities, and the teachers who facilitate them, may enjoy multilayered support as well as external content expertise.[13]

As intimated above, an important feature of stimulating change is structuring systems that enable the flow of new knowledge through the system. Thus, a concern for the Institutes might be providing some evidence of a cascading system, that is, one in which an expert educator provides training to district-wide or school-based lead teachers who in turn share their knowledge and skills with classroom teachers through learning communities, study groups, coaching, co-teaching, or modeling instructional practices.

As with other aspects of the MSPs, the Institutes embody a wide array of structures. On the one hand, there are structures that provide as-needed mentoring but no formal leadership training. Despite this lack of structure, one Institute's expectation was that participants find ways to share what they had learned with other teachers in their schools (45). On the other hand, there were carefully coordinated leadership trainings for teachers, administrators, and IHE faculty designed to have the greatest impact throughout the school or district (42 and 46). One Institute asserted,

> *The value of bringing teachers together around a common goal to enable them to form a community, along with the need to provide outside expertise to push their thinking... [and] where teachers share ideas about lessons, collectively reflect on what works with students and what does not and why, and invite each other into their classrooms so they can become better at reaching students—seems to be a central element in improving instruction* (42).

[13] In at least one case, the district is now covering the costs of teachers' planning time (42). Most, but not all, of the Institutes appear to value job-embedded professional development. However, as Moyer-Packenham et al. (2009) point out, there are structural features of these efforts that can slow improvements.

Between these two types of structures are more traditional train-the-trainer systems that seek to extend the reach of knowledge and skills gained by Institute participants (45). At one Institute, 60 percent of principals reported having systems in place so that non-participating teachers were able to benefit from Institute activities (47).

Some of the Institutes' strategies for bringing teachers together or supporting the notion of learning communities at the school-level include public teaching, opening doors, study groups, video clubs, or simply providing more traditional professional development to rural, remote, or isolated teachers (42 and 43).[14] In small rural communities, lead teachers may experience a special vulnerability in community-wide, and not just school-wide, resistance or sanction if initiatives prove unpopular.

Extremely limited funds for professional development within participating school districts led one Institute to develop a group study manual and to place its courses on CD-ROMs in hopes that competent instructors might make use of them (48). And, distance learning communities at two Institutes offered alternative, if less desirable, options for teachers to dialogue and share experiences with others (42 and 47).

In yet another example of structure, one Institute developed teams comprised of two teachers and their school's principal. The teams are then committed to engaging the balance of the mathematics teachers in their respective schools in collaborative planning in professional learning communities (49). The effort underscores the importance to community building of reaching critical mass. Developing an influential group of mathematics or science teachers from a given school was a key feature of another Institute's model (42).

As one Institute evolved, it pressed for strengthened connections between school administrators and its MSP activities while trying to recruit multiple teachers from the same

[14] One Institute is targeting rural teachers to balance the preponderance of teachers from urban and suburban settings who are overrepresented among its participants (44).

school: "When there is greater administrative buy-in and when there is greater representation within the school we see the greatest and most sustained impact" (47). This is confirmed in one case where uneven buy-in underscored the importance of having a critical mass of informed teachers which, "makes hiring a critical part of expanding and sustaining the teachers' work" (47). One Institute's ability to generate self-sustaining study groups meeting after hours and beyond the funding period is evidence of the vitality of learning communities. Equally noteworthy is the fact that faculty voluntarily joined these no-cost groups (48).

In terms of systemwide participation, on average, Institutes appeared to be engaging about 20 percent of eligible mathematics and science teachers, but the range starts as low as six percent and goes as high as 40 percent. Unfortunately, Institutes do not report participants as a percentage of all mathematics and science teachers by grade, by school, or overall. In addition, MSP-MIS data were incomplete for a number of items that might shed light on participant rates among eligible teachers (Exhibit 5 provides an example of potential double counting or inclusion of non-MSP funded participants contained in annual and evaluators' reports). Thus, assessing the attainment of critical mass among Institute participants remains illusive.[15]

All of the Institutes were measuring some aspect of their respective impacts on local educational communities. Each of the Institutes under study had conducted classroom observations to gauge the extent to which participants were applying the knowledge and skills they have acquired through the MSP Program in classroom implementation. The impacts on classroom practice varied. For example, one Institute has concentrated on teacher and student discourse to better understand how teachers and students communicate during class and thereby assist teachers in reflecting on the effectiveness of their

[15] Additional information on Institute participants could be especially helpful for developing future professional development programs designed to build leadership. These data would include the number of participants returning to their previous posts or moving up career ladders to positions of greater responsibility either within their schools or their districts; and the extent to which participants are facilitating job-embedded professional development, or taking part in distance learning or academic year distance learning following Summer Institute trainings.

instructional approaches for different levels of cognitive demand (49). There also is evidence, as a result of Institute training, of increased co-teaching, greater integration of technology use, enhanced use of new assessments, and the introduction of new curricular units, materials, or instructional approaches (44, 45, and 47).

While seven of the eight Institute Partnerships track professional development impacts to classrooms through observations, only one mentioned focusing on participants' abilities to "establish learning communities on their campuses" (43). Thus, little information was available on tracking the progress of lead teachers who are acting as catalysts within their schools as a consequence of their Institute participation. Nor was there much discussion of changes in effectiveness resulting from employing job-embedded professional development.

Evidence of Empowerment. Another feature of learning communities is empowerment. One Institute has made action research a centerpiece for empowering teachers to collect, analyze, and use data to improve instruction and student assessment (48). Two Institutes incorporated curriculum and lesson planning in their course work to ensure that participants are prepared to take decision making roles in shaping instruction within their respective schools and districts (46 and 47). Elsewhere, evidence that teachers have made curricular changes indicates both competence and authority. One Institute has encouraged participants to "create their own leadership plans based on experience, school, environment, and personal interest," adding, "This organic approach and emphasis on having the requisite knowledge to lead seems right" (47). That Institute reported a considerable number of teachers who have changed their science curriculum (34 percent), topics (48 percent), materials (83 percent), and/or assessment methods (79 percent) (47).

At the other end of the spectrum, the creation of a resource center at one Institute has provided a central clearinghouse for resources and distributes mini-grants, building a community that might appear to be the antithesis of a site-based, empowered community (46). Nonetheless, both progress and sustainability in either of these cases may be threatened by budget cuts or other constraints, or enhanced through collective commitment. Traditionally, such cutbacks would likely cobble improvements. The emphasis on embedded or distributed leadership seeks to overcome these constraints on getting needed expertise to the classroom.

Overall, as a first step in supporting potential leaders, staff have created clear selection criteria to tap promising candidates. Yet, these criteria reflect the challenges in relying on some combination of credentialing, grade-level or content expertise, or professional recognition to identify those individuals who are most likely to realize the Institutes' objectives. Meeting these selection criteria may have been further constrained by the shortage of even partially qualified individuals, especially among those who are representative of diverse student populations.

Institutes also had quite different approaches to allocating resources, with some investing heavily in the training of a few potential leaders, while others are spreading resources in order to reach a larger number of non-participating regular classroom teachers or the administrators who support them. This may explain why not all the Institutes offered leadership training while some relied on less formal team building activities to serve as leadership forging opportunities.

Finally, all of the Institutes were working to optimize the ways in which teachers can be brought together so that knowledge flows throughout the entire learning community. Although the Institutes conducted classroom observations, as a group, greater concern was devoted to confirming changes in teaching practices than in measuring impacts either on establishing learning communities or on improving student achievement.

3. Is there evidence that Institute participants have contributed to the development of challenging courses? As noted above, research suggests a positive relationship between teachers' involvement in designing courses and curriculum and their motivation in reform efforts that lead to increased student achievement. However, Exhibit 8 shows that only one of the five Institutes with teacher participants engaged in designing courses were working on courses at the K-12 level. The other Institutes have been crafting courses for professional development offerings for summer or academic year institutes. Still, many of the MSPs' documents noted that teachers within learning communities and study groups are developing some course materials or instructional practices based on examination of curricula and student achievement data (42, 43, and 48).

Although the MSP Program's objective is to engage teachers in courses that challenge K-12 students, participants' work on designing Institute courses may have a positive, if less direct, impact. Of the five Institutes that explicitly mention teachers' engagement in designing courses, only one provided the exact number of those involved, i.e., only two teachers helped with course design (43). For the most part, teachers contributing to course design were part of a team of educators that included IHE faculty. Few details were provided as to their exact contributions. Fairly general descriptors such as "input" and "work with" denoted teachers' contributions as described in the Institute Partnerships' annual and evaluators' reports.

Given the explicit nature of this Institute objective, it is not clear why so little information about teachers' contributions to course development was provided among Institute data sources. It may be that these Institutes did not report ongoing activities or they had nothing to report. Another possibility is that teachers lacked the authority to make changes to school curriculum, whereas some master teachers were encouraged to do so within the context of the Institute courses which they frequently co-teach. The level of content mastery also may be an important factor. In one instance, MSP-PE's fieldwork data indicated unexpectedly low levels of content knowledge among participants. In that case, Institute staff may have determined that teachers were not in a position to contribute to course development. Yet in another case, teachers drew on their pedagogical expertise to help content experts adapt training to be more accessible to middle school teachers (45).

4. Is there evidence that Institute activities have reached all students? Attempts to reach all students may be viewed as a three-step process. First, Institutes may develop partnerships that blanket a region or number of school districts, or that focus on higher-risk populations in attempts to level the playing field among lower achieving students (three Institutes engage one teacher to lead at each participating school) (43, 44, and 48). Second, Institute-trained lead or master teachers may reach out to all mathematics or science teachers in a given school or district through a cascading or train-the-trainers system. And, third, all teachers in participating schools may reach out to all students.

Any stage of this process may be influenced by the skills, knowledge, and demographic backgrounds of participating teachers and, by extension, local learning communities and the body of students they serve. In this respect, the composition of the body of participating teachers is an additional facet of the recruitment process discussed above but more appropriately treated here where teacher diversity is discussed in terms of its potential influence on student achievement.

Among the series of substudies undertaken by the MSP-PE, in their examination of teacher diversity Moyer-Packenham, Parker, Kitsantas, Bolyard, and Huie (in press) highlight the discrepancies between teacher and student demographics in many of the nation's schools. The authors note the importance of achieving a diverse teaching force and identifying a number of strategies for achieving that goal. Arguments for teacher diversity include the perspective that a culturally diverse and responsive learning community is needed to reduce achievement gaps among diverse student groups and the idea that role models are important in relating to diverse students' backgrounds and experiences. In this respect, teachers can serve as bridges between schools and families or communities.

Yet a variety of conditions appear to inhibit minority enrollment and completion of teacher education programs, especially those that focus on mathematics and science. These conditions include poor minority preparation due to inadequate K-12 education and subsequently higher failure rates, financial and economic constraints, and limited counseling and guidance. Further, multicultural education courses seem to focus on White teachers working with minority students, offering little preparation for minorities to use their strengths in the classroom. For those minority students who actually become teachers, attrition rates are higher, which may be due in part to their more frequent placement in low-performing schools.

Thus, successful strategies for increasing teacher diversity address recruiting, supporting licensure, induction into teaching, and retention of diverse teachers. However, Hodgkinson (1999) cautions that many of the nation's school districts are homogenous and may have little incentive to diversify their teaching forces. Any national initiative aiming to redress a lack of diversity will need to examine the local context in terms of the match between student and teacher demographics.[16] Beyond such general social conditions, as a group, about half of the MSP projects set increasing teacher diversity among participating school districts as a goal, employing a range of *actionable* strategies (Moyer-Packenham et al., in press).

Based on their findings, Moyer-Packenham et al. (in press) conclude that numerous strategies that form a comprehensive approach to teacher diversity are likely to yield positive results. The authors point out that MSPs tended to neglect the induction and retention years of teaching, and would therefore benefit from a more balanced focus on increasing teacher diversity. Further, they argue that higher rates of minority participation will be needed in order to achieve increased diversity in mathematics and science education. Their study found that eligible minority teachers participated in MSP activities at higher rates than eligible White teachers in the same districts.

NSF's MSP Institute Partnerships are committed to the notion that improved teaching will eventually lead to enhanced student performance. With that commitment, the

[16] This is the case in one Institute that can draw only on its homogeneous population of White teachers to serve student populations whose diversity is rapidly increasing (44).

importance of reaching all students should be well understood by any teachers acting as leaders who are responsive to the diverse student populations of any given school or district. All of the Institutes have stated the intention of reaching all students. However, their strategies for doing so are less evident. Only one Institute listed a course on diversity. More typically, Institutes reported efforts to equalize access to more challenging courses. For example, as a result of Institute participation, an entire school adopted a uniform algebra curriculum for the first time (42). Another Institute targeted efforts to increase the number of secondary students prepared for careers in science by beefing up curriculum for all grade 5-12 students (46). Yet, another Institute offered an entire course specifically directed at “Actions to Engage All Students” (43).

In terms of evidence, some preliminary self-reported data suggests that at one Institute the number of teachers who provided challenging curriculum to all students increased for one of its cohorts (48). Other Institute participants reportedly focused on maximizing learning for all students by reflecting on students’ data-based needs (49).

Nonetheless, the demographic disparities between district teachers and the students they are meant to serve may be difficult to overcome without aggressive recruitment initiatives. Although MSP-MIS data suggest that minority participants are overrepresented among the comprehensive and targeted MSPs, the strategies that Institute Partnerships have utilized to ensure that teacher leaders are responsive to, and competent at engaging, diverse student populations lacks sufficient detail to be adequately assessed without more complete demographic data on actual Institute participants.

5. To what extent have STEM faculty been involved in supporting the Institutes’ activities? Gauging faculty involvement is rendered more challenging by the frequent lack of distinction among STEM faculty and education or other faculty members among the various MSP data sources. For example, in Exhibit 9, academic year activities are reported for IHE faculty and administrators as one group, with no possibility to discern the specific contributions of STEM faculty. Within this constraint, the aggregated MSP-MIS data show predictable patterns indicating greater faculty involvement at start up (2004-05) than after courses are underway, and relatively less engagement in management than other activities (Exhibit 10). This pattern was borne out by data collected through MSP-PE's fieldwork (43).

In the context of Summer Institutes, MSP-MIS data indicated greater IHE faculty and administrator engagement in teaching courses to increase mathematics and science content knowledge (50 percent) or instructional skills (45.8 percent) (Exhibit 11). During the academic year, the most frequent type of IHE faculty engagement was to "remain on call" (46.9 percent) followed by conducting workshops or courses (39.6 percent) (as seen in Exhibit 9).

IHE faculty received some form of training in five of the eight Institutes and two Institutes report subsequent changes to the regular courses taught by participating faculty. Beyond the benefits faculty report in co-teaching with high school teachers, one Institute could boast of having a chapter on co-teaching accepted for a forthcoming book (46).

IHE faculty engagement among Institutes has differed somewhat in comparison with engagement in comprehensive and targeted MSPs. Given their emphasis on mathematics, it is not surprising to find among the Institutes a larger portion of faculty whose field of instruction is mathematics (48 percent in 2004-05 and 42.7 percent in 2005-06) in contrast to comprehensive and targeted faculty (33.6 percent in 2004-05 and 24.8 percent in 2005-06) (Exhibit 12). The level of IHE faculty and administrator engagement in Institutes appears slightly higher than among other types of MSPs (Exhibit 13). Although aggregated MSP-MIS data on faculty engagement does not distinguish STEM and non-STEM faculty, the number of Institute faculty involved for more than 200 hours increased to 55 percent in 2005-06 compared with a decrease to 42.4 percent among comprehensive and targeted faculty during the same period. These findings point to the limitations of establishing prevalence in seeking to understand the effective qualitative impacts that result from the efforts of even a very limited number of highly motivated STEM faculty.

At the same time, MSP-PE's fieldwork provided more direct evidence of long-standing or enthusiastic STEM faculty engagement among some of the Institutes. For example, at one Institute, STEM faculty have formed the core of a long-term statewide effort to enhance education through the development of graduate programs for master mathematics teachers. The resulting mathematics specialists receive state-approved licensure. These efforts converge well with Institute Partnership objectives, benefitting some STEM faculty who received tenure during their MSP involvement (44).[17]

Some STEM faculty also have shown enthusiasm for working with K-12 districts for the first time. At one Institute, a mathematician was drawn to co-teach Institute classes, while a professor in that IHE's Department of Statistics became intrigued with the Institute's research into its impacts on classroom practice and subsequent links to student achievement (48).

In a reversal of traditional roles, mathematicians at one IHE were viewed as leading mathematics reform efforts in the region, while little change has been seen within that IHE's Department of Education. The Mathematics Department effort was led by an individual with a 20-year commitment to K-12 education through involvement in national reform efforts (45).

Among the challenges encountered among IHE participants noted during MSP-PE's fieldwork were constraints imposed by tenure and promotion requirements, especially for faculty in STEM departments that do not value K-12 efforts or related research (46). In this regard, structural changes among IHEs may require a longer time horizon to implement and senior or tenured faculty may be needed to champion their cause.

[17] STEM faculty at this IHE also received recognition for mathematics education research.

Further Comparisons among Institutes, Comprehensive, and Targeted MSPs.

Given the range of partnerships found within NSF's MSP portfolio, it is helpful to examine differences in teachers' commitment as represented by their immersion in training programs found among the comprehensive and targeted MSPs and those found among Institute Partnerships. Unlike other award types, Institutes must design intensive trainings that acknowledge that "teachers need multiple, coordinated experiences of sufficient duration to help them build the critical capital needed" (NSF 03-541).[18] Exhibit 14 provides a comparison of the professional development focus by MSP type, i.e., comprehensive, targeted, and Institute.

The data in Exhibit 14 show that the Institutes compare favorably in focusing primarily on providing networked or supported professional training designed to reach an extended number of classroom teachers. As seen in the lower right-hand cell, the proportion of Institutes that fall within this category is higher than those for any other award type (25 percent compared to 20 percent of targeted and 9.1 percent of comprehensive MSPs).

Exhibit 13 presents evidence that IHE faculty have been highly active in all types of MSPs, with nearly half involved for more than 200 hours in a given year. Faculty involvement in Institutes was slightly higher than for the comprehensive and targeted MSPs. These levels were especially important given that a majority (50.2 percent) of participating faculty are tenured, with professors comprising nearly one-third and associate professors just under 20 percent of the totals (Hershey-Arista et al., 2007, Table E.2.3). Further, IHE faculty involved in Institute activities were most likely to be on call during the academic year (see Exhibit 9). This contrasts with greater IHE faculty involvement in conducting workshops or courses among comprehensive or targeted MSPs.

[18] See Moyer-Packenham et al. (2009), another MSP-PE substudy that addresses the issue of the length and duration of professional development experiences.

D. Discussion

Along with the programmatic objectives discussed above, this substudy's findings also may be viewed in relation to an emerging set of strategies for career development that build on NSF's early Summer Institutes but extend these approaches in light of current professional development trends.[19] In its solicitations, NSF stressed that "successful proposals for a new Institute Partnership will reflect the enthusiasm and disciplinary spirit of the original NSF Institutes, while responding to 21st Century needs for accomplished teachers who are intellectual leaders and master teachers in K-12 mathematics and science" (NSF 06-539). In response, one Institute promised to keep alive "the vision created by the successful NSF Summer Institute Program" but offered "a new breed of Institute" that would help participants assume leadership positions in their classrooms, schools, and professional communities (47). Among the innovative aspects of this "new breed of Institute," one Institute extended the early Summer Institute approach by offering long-term and on-site support, a sustainable online structure, and research opportunities.

To capture the distinctive contributions of the Institutes, a review of activities might consider the *connections* among activities that are mutually supportive or convergent and the comparative degree to which coordinated activities lead to improved student achievement. Also, alignment with ongoing school or district activities may prove even more critical in nurturing the type of learning communities envisioned by the Institutes and supported through their efforts to place teacher leaders in key positions. Thus, concerns with "what works" must be paired with considerations of each locale and its capacity for training.[20] Here, IHE faculty play a role in aligning activities. Finally, the geographic

[19] In a 2007 Council of Chief State School Officers (CCSSO) report, Blank, de las Alas, and Smith rated the quality of professional development programs using five categories: 1) content focus, 2) active learning, 3) coherence of professional development, 4) collective participation of teachers, and, 5) sufficient time or duration and frequency of professional development activities. One Institute, included in the CCSSO report, was rated positively in all five categories.

[20] In this sense the MSP Program's first three cohorts may be considered 48 laboratories with a constant flux of teachers and funding. If an intervention improves STEM education, it is unlikely to represent a "silver bullet," although it may enjoy a small window of opportunity for a time.

dispersion of eligible participants presents unique challenges for teacher leaders striving to act as catalysts within schools or school districts.

***Connectivity*.** NSF's objectives for the Institutes have guided the connectivity among activities. The relation of these activities to student achievement is more evident among Institutes through their greater emphasis on developing learning communities (in contrast with professional development for individual teachers), and on utilizing teacher leaders as catalysts within a community of mathematics or science teachers. In preliminary analyses, six Institutes (43, 44, 45, 46, 48, and 49) had tracked student achievement, yet, only two appeared to utilize robust analytic tools to link student performance with participating teachers (46 and 49). However, the preliminary results for these two analyses were similar to the other four in being either mixed or inconclusive. One of these Institutes' more recent (2009) evaluators' reports *does* indicate a strong positive correlation between observed classroom implementation of training participants' practices and improved student achievement (49). For both elementary and secondary schools, the data show that students from schools that carried out key aspects of that Institute's objectives were more likely to meet proficiency standards than students in schools without those traits. With two Institutes not providing any student achievement data thus far, the Institutes' student performance data, especially in relation to the level of teacher engagement, should continue to be carefully tracked.

Similarly, three Institutes have measured the potency of professional learning communities in enhancing improvements in STEM education. Two have utilized social network analysis and another has conducted case studies consisting of stratified assessments of the various members of a set of professional learning communities (42, 48, and 49). In addition, another Institute has tracked support for newly trained lead teachers among participating schools (44).

Apart from the Institutes evaluating the impact of the relationships among members of professional or job-embedded learning communities, attempts to measure success appear to run in parallel (rather than being correlated with each other) and may fail to capture the synergy needed or produced to achieve catalytic change. In lieu of robust measures of synergy, tracking how information is shared or disseminated through a learning environment may provide useful information. Or, learning more about the nature and quality of learning networks may reveal both opportunities and more specific information about challenging constraints.

***Alignment with School and District Needs*.** Alignment appears to be a key influence on the effectiveness of Institutes' activities as they seek to meaningfully link professional development to ongoing classroom, school, or district activities and needs.[21] A facet of the effort to align supply with demand is the capacity of individual teachers to wield the authority to make needed changes (see MacNeill, Cavanagh, and Silcox, 2005 for a discussion of pedagogic leadership).

In terms of standards, at least two Institutes have aligned their efforts with state standards, while yet another is aligning theirs with National Council of Teachers of Mathematics standards. However, tensions arose in one case when an NSF-funded Institute's objectives for local professional development conflicted with those for a state-level MSP project funded through the U.S. Department of Education (42).

IHE faculty also have played a role in supporting a coherent and converging set of activities. Exhibit 10 indicates greater IHE faculty attention to aligning curricula with other courses and research-based mathematics and science instructional methods than any other planning and development activities except collaborations with other IHE faculty.

***Bridging Distance*.** The challenge of providing professional development that aligns with district efforts and local structures is acknowledged by at least one Institute engaged in

[21] There may be something to learn from one Institute Partnership whose approach reportedly dovetailed nicely with the superintendent's campaign to develop professional learning communities: three of the Institute's participants have won Presidential awards (48).

testing its ability to provide training that can be applied in geographically dispersed school districts (42). Early results suggest that flexibility is needed in applying the knowledge and skills acquired during off-site training, with the degree of local empowerment counting as an important factor in implementing any changes to science and mathematics education. Despite their limitations, distance learning and online communities also may be important vehicles for bridging distance. One measure of success in bridging different school systems is replication. One Institute's model, promoting lesson study and deep content work within professional learning communities assisted by STEM faculty, is being replicated regionally (49).

Refining Professional Development Strategies. Collectively, the Institutes may be seen as exploring the ways in which K-12 and IHE partnerships are contributing refinements to professional development strategies. The Institutes' efforts embody the range of reform structures outlined in the literature reviewed above, playing to their respective strengths through faculty mentoring or through all-teachers-are-leaders efforts that constitute new models of career development. Each Institute represents a different take on researching and utilizing model strategies and practices. It also is noteworthy that there is cross-fertilization of ideas among the Institutes facilitated during NSF's annual MSP Learning Network Conferences and continued throughout the year by some Institutes with common interests.

Despite some promising analyses, at this stage, there is insufficient data linking a particular Institute's approach or structure with the distal goal of improving student achievement. However, there has been progress on the more modest objective of developing a cadre of teacher leaders who can stimulate improvements to STEM education within their respective spheres of influence. One Institute boasted that it has increased the number of teachers prepared to teach at the high school level by 50 percent (43). Another Institute conferred master's degrees on 60 participants in its first two cohorts (48). In other measures of success, there is evidence that at least one Institute exceeded its recruitment goals and managed to retain all but a few participants from four cohorts (48).

Structure and Scale. The fact that there is no clear pattern or configuration across the Institutes is evident. This lack of shared structure provides little information about common shifts in district level support (Moyer-Packenham et al., 2008). Nor is there much data on how teachers' or administrators' roles have been revamped as a result of participation in Institute activities.

Undaunted by the challenges of bringing collaborative learning communities to scale, one Institute planned to institutionalize a mathematics specialist graduate program statewide (44). Structurally, the partnership institutionalized its program by ensuring that Institute alumni would be hired back in their districts as school-based mathematics specialists. Another Institute hoped to create "reflective professional communities statewide" (49). These approaches more directly address the issue of increasing the number of STEM educators. Few Institutes make direct reference to increasing entrants to the STEM pipeline, although one aimed to entice more secondary school students to prepare for STEM careers and noted that a former participant is now co-teaching an Institute science course (46). Another stipulated that its teacher leaders would be employed as full-time mathematics specialists by the school district after completing the agreed-upon course of study (44).

Another dimension of structure was revealed when a shift in culture was noted at one school where teachers working on vertical alignment reported an improved ability to focus on substantive issues. Due to the quality of team work within the school, expectations for new hires were raised, with candidates being asked to commit to the kind of group work and collaboration that have become part of this learning community (42).

Barriers to Success. Those Institutes that appeared less successful were encountering barriers to nurturing professionalism, empowerment, and collaboration. The lack of prior knowledge appears to be an impediment for some Institutes where STEM faculty have had to reduce expectations for the level of content knowledge that teachers may gain, while other Institute participants have shown an alacrity and readiness to learn that energizes and sustains the learning community. Thus far, data associated with recruitment criteria shed little light on which strategies were most effective in generating the best pool of Institute candidates.

There is some evidence that administrator buy-in has led to greater impacts on instructional practice. Yet many district policies and structures may constrain local application or sharing of the knowledge and skills gained through Institute training. Not least of these constraints is the reassignment of trained teachers to teach other subjects or grades, or to move to different locations. Yet again, Institutes provided little data on the progress that they are making in tracking participants. Additional challenges that are common across the Institutes are discussed next.

Another Institute feature receiving scant attention is the relationship between the depth, intensity, or duration of training and achievement of the program's goals of increasing the number of school- or district-based intellectuals or master teachers. On this score, careful attention should be given to the background and prior training found among the Institutes' participants as well as the type of training that most effectively prepares them to become resources for their peers or to catalyze learning communities and thereby improve student achievement in mathematics and science.

As with any professional development effort, the Institutes are grappling with the challenges of flexibility, commitment (motivation), turnover, and time. Evidence of these challenges from the MSP-MIS is seen in Exhibit 15. Yet the data for the second year of implementation suggest that some of these issues were resolved or attenuated. Still, one Institute that sought to engage principals in its learning communities noted a 35 percent turnover rate among the heads of its participating schools (47). Similarly, Exhibit 5 shows discrepancies between recruitment and retention numbers, with teacher turnover likely accounting for failure to meet participant objectives.

E. Placing the Institutes in a Career Development Context

The context for Institute activities may be conceived as many concentric circles. At the outermost ring is the global arena in which the U.S. competes for STEM-related jobs and prominence. Activities on the global stage provide a context for national standards, policies, and initiatives such as NSF's efforts to improve STEM education, including the MSP Program. Yet the MSP Program must acknowledge state and regional contexts that may facilitate or constrain efforts to develop and support science and mathematics learning communities. School districts offer similarly varied contexts in which national initiatives may be well or ill received, depending on the extent to which external initiatives align with internal ones. As with Bronfenbrenner's ecological model of human development (1979), the community of learners that comprises a school or classroom is influenced by the many forces or contexts that surround its core activities.

As but one type of MSP award, Institute Partnerships are rightly compared with comprehensive and targeted MSPs in respect to whether the Institute design or configuration is sufficient in creating a learning community better able to impact instructional practice, and thereby improve student achievement. In fact, some comprehensive and targeted MSPs appear to support the kinds of learning communities that are the focus of the Institutes, although that is not their sole activity. A comparison of training courses among the three MSP types might reveal finer distinctions in the knowledge and skills that participants in the respective types of awards are receiving. Unfortunately, comparisons in terms of leadership training and experiences, or the level of content mastery, were beyond the scope of this study.

In sum, the current study examined the distinctive features of the MSP Program's Institute Partnerships. The study found an array of models ranging from more traditional configurations to ones that are testing the benefits of viewing all mathematics or science teachers as potential leaders within their schools, whether those schools are formal hierarchical organizations or flat learning communities.

The findings suggest that teachers are deepening their content knowledge while embracing a variety of positions as teacher leaders within their respective learning communities. For some Institutes, STEM or education faculty are playing key roles in designing and delivering relevant training courses with increasing support from their respective departments, colleges, or universities. Yet, there was scant evidence of teachers' involvement in designing challenging K-12 courses or of specific strategies for engaging all students.

When the Institute Partnerships are considered in light of the need for increased numbers of teachers with long-term commitments to their career development, an additional dimension is added to interpreting these findings. Beyond the accomplishment of NSF's MSP goals, the Institutes could offer innovative models for professional training as well as a new template of expectations for the professionalization of STEM teachers. For the mission of the Institutes is nothing less than to encourage the kind of career development that will keep teachers in a well-regarded, challenging field, one with closer ties to faculty and their respective colleges and universities.

For now, the Institute Partnerships are clearly a work in progress, one that will need to strengthen its offerings to teachers while keeping in mind the more distal goal of improving STEM learning for K-12 students. Site visit data underscore the concern with providing meaningful training in workable environments, as Institutes have adapted their designs to accommodate additional partners (such as school districts or community colleges) while adapting measures of process amidst a range of policy adjustments. These realities may translate into constraints on greater innovation in designing and delivering professional development for the 21st century. To date, there is no compelling evidence that one type of Institute is more positively impacting teaching and learning. More data will need to be adequately tracked to determine the relevance of the Institutes' professional development to improving learning. Special attention will need to be paid to how that training aligns not just with standards and existing content but with challenging K-12 curriculum.

As a group, the Institutes have engaged in both traditional and reform professional development activities, with all of the practices associated with distributed leadership or professional learning communities well represented. However, the Institutes also offer examples of the contradictions pointed out in the literature.

The Institute data are rife with examples of balancing hierarchical considerations while striving for equality among classroom teachers eager to participate in shaping their schools' STEM agendas as well as advancing their careers. The Institutes' participants are not spared the tensions wrought by the need to meet mandated objectives while trying to adapt classroom practices so that diverse learners achieve deeper understanding. Yet each of these experiences may help to clarify current notions of professionalism, career development, empowerment, and collaboration as well as systemic constraints, and the unique opportunities afforded by K-20 partnerships.

Specifically, the Institutes' efforts to study the links between the various practices employed by Institute participants and student achievement will represent an important contribution to understanding the type of professional development needed to improve the nation's stature in mathematics and science education.

Exhibit 1

RESEARCH QUESTIONS

	Research Questions	Relevant Quotations from Solicitation NSF 03-605
1.	Is there evidence that the Institutes' courses of study have provided teachers with a deeper understanding of mathematics and science content?	…deepen their knowledge of the subjects they teach. …provide coherent study within a particular discipline(s). In the Institute, teachers will focus on the intellectual substance of the subject they teach and the special knowledge needs for its teaching… …multiple coordinated experiences of sufficient duration to help them build the critical capital needed.
2.	What support have Institute Partnerships provided to enable teachers to become school- or district-based leaders? - Do recruitment strategies support these approaches? - What special training is provided? - Is there evidence that teachers are subsequently serving as catalysts within their schools or that professional development is job-embedded?	…build leadership skills…They will be catalysts for the reform of mathematics and science education programs in their schools… …teachers who are intellectual leaders and master teachers in K-12 mathematics and science…school- and district-based intellectual leaders and accomplished practitioners in their disciplines. …they will become resources for their peers and their profession. …no longer see themselves as isolated individuals but rather as members of a professional community, linked with others devoted to learning and practice. …alignment of the teacher leadership effort with *ongoing* educational improvement and reform in mathematics and science…increased responsibilities for the emerging teacher leaders in their home organizations as a result of successful completion of the Institute…administrative support, time, resources, and recognition/rewards commensurate with this increased responsibility. …schools and districts are encouraged to support *small* teams of Institute participants.
3.	Is there evidence that Institute participants have contributed to the development of challenging courses?	… will contribute to the development of challenging or advanced courses.
4.	Is there evidence that Institute activities have reached *all* students?	…developing an accomplished teacher workforce capable of engaging all students.
5.	To what extent have STEM faculty been involved in supporting the Institutes' activities?	…professional communities grow among K-12 teachers and college/university faculty and researchers in mathematics, the sciences, engineering and education… Instructors will include…faculty…from mathematics, the sciences, engineering, and education who model effective pedagogy.

Exhibit 2

CHARACTERISTICS OF THE INSTITUTE PARTNERSHIPS

Institute No.	Academic Subject(s)	Grade Level(s)	Core Partner(s) (N)	School/District Partner(s) (N)	Description of Summer and Academic Year Sessions
42	Math	High school, Middle school	5	3	- 3-week summer institute - Academic year workshops - Once-a-month Video Club during academic year - Two-week training for teacher leaders during academic year
43	Math	High school	2	2	- 4-week summer institute - Academic year meetings of Professional Learning Communities - Ongoing mentoring
44	Math	K-5	6	8	- 20-day summer institute - Online course during academic year - Regular meetings of Working Group during academic year
45	Math	Middle school	1	1	- 3-week summer institute - 2-week academic year workshops - Evening graduate level courses during academic year - End-of-semester pedagogy conference and mentoring
46	Science, Math	High school, Middle school	3	45	- 12 summer courses - 6 Administrators' Science Education Academy summer sessions - 4 academic year courses in pedagogy - 4 academic year courses in science content - 3 Administrator's Science Education Academy sessions held over the academic year
47	Science	K-8	2	1	- 5-day summer institute - Semester-long (13 weeks) graduate level science education course
48	Math	5-8	19	83	- 3-week summer institute - Four academic year courses offered: three math content, one titled "Teacher as Scholarly Practitioner" - 2 academic-year workshops
49	Math	K-20	3	10	- 3-week summer institute - Academic-year workshops (online)

Source: MSPs' annual and evaluators' reports, MSPnet, and MSP-PE's site visit notes.

Exhibit 3

REPORTED TEACHER CONTENT KNOWLEDGE GAINS, BY INSTITUTE PARTNERSHIP

Institute No.	Assessment and Subject	Respondent(s)	Results
42	Random survey: mathematics content knowledge	Randomly selected Summer Institute participants	"Teachers mentioned increased knowledge of probability ('stretched my knowledge into places I did not know existed') and that post-Summer Institute they changed their approaches to teaching, using more groups and encouraging students to discuss the mathematics," 2007.
	Post-course self reports: mathematics content knowledge	Summer Institute participants, including non-MSP participants	"Post course self reports from the [summer institute] teachers indicate a substantive gain in content for many teachers, although these data include teachers other than [MSP] teachers. Pre and post-tests given before and after the summer training show statistically significant improvement in teacher content knowledge (pre-post test difference of 16%) with p-value <0.001," 2007.
	Web-based survey: mathematics, curriculum, teaching	Summer Institute participants, including non-MSP participants (N=25)	"Out of the 25 respondents who included comments about secondary schools, five commented directly on secondary school content, five on curriculum and seven on teaching. Two respondents indicated that their knowledge of mathematics content had increased... One stated that s/he [was] comfortable with the content before attending [summer institute] but found the group interaction beneficial. The other two respondents indicated that they were continually learning. Six participants commented on secondary school curriculum. Two noted that their knowledge and understanding of secondary school curriculum had increased. Two stated that there was no change in the level of their knowledge of secondary school curriculum," 2007.
43	Pre/post content knowledge test: geometry	Institute participants (N=28)	The mean post-test scores were 33.35% higher than the mean pre-test scores. The change in score was statistically significant, 2007.
	Algebra	Institute participants (N=28)	The mean post-test scores were 36.2% higher than the mean pre-test scores. The change in score was statistically significant, 2007.
44	Pre/post content knowledge assessment: *Algebra and Functions*	Cohort 1 participants (N=26)	The mean post-test scores were 29.65% higher than the pre-test scores. The difference was determined to be statistically significant, 2007.
	Numbers and Operations	Cohort 2 participants (N=27)	The mean post-test scores were 13.93% higher than the pre-test scores. The difference was determined to be statistically significant, 2007.
	Geometry and Measurement	Cohort 2 participants (N=27)	The mean post-test scores were 18.52% higher than the pre-test scores. The difference was determined to be statistically significant, 2007.
45	Teacher survey: mathematics	2005 and 2006 Cohort teachers	"Responses from teachers in the 2005 and 2006 cohorts on a survey instrument designed to assess levels of teacher confidence in their understanding of mathematical content related to the [state standards] indicates that longer participation in the [MSP] yields higher scores than those achieved by teachers who have been in the program for a shorter time. Differences between cohorts were statistically significant at the [sic] or better on nine out of twelve [state standard] items. Though not statistically significant, differences on the remaining three items were also in the right direction," 2005 and 2006.
	Pre/post content knowledge test: mathematics	MSP graduates (2005 cohort), NSF teachers (2006 cohort), Summer Institute High School participants and Middle School Participants (2007 cohort), Preservice Elementary Education Candidates.	MSP graduates (from the 2005 Cohort) scored an average of 21.09 (out of 25) on the assessment, NSF teachers (2006 Cohort) scored an average of 18.05; High School Participants (from the 2007 Cohort) scored an average of 18.78, Middle School Participants (from the 2007 Cohort) scored an average of 15.93 points, and Preservice Elementary Education Candidates (who had no prior contact with the Institute) scored an average of 13.62. Statistical comparisons show that there is a significant statistical difference in assessment scores between the MSP Graduates (who have been involved since 2005) and the Middle School Participants (involved since 2007) as well as the NSF Teachers (involved since 2006). This indicates that longer involvement in the MSP yields higher scores, 2007.

(Continued)

Exhibit 3 (Continued)

Institute No.	Assessment and Subject	Respondent(s)	Results
46	Pre/post content knowledge test: Middle School science	Cohort 1a Teachers (N=21)	The mean score increased by 14.28% between the Pre-Test (2005) and the Post-Test (2007). The result is statistically significant, 2005 and 2007.
	High school chemistry	Cohort 1b teachers (N=17)	The mean score increased by 11.39% between the Pre-Test and the Post-Test, 2005 and 2007.
	ePortfolio: Science	Cohort 1b teachers (N=16)	12.5% of MCEP teachers' ePortfolios passed on the first reading (which judged content and pedagogy), meaning that 87.5% of the ePortfolios needed revision and resubmission. The lowest scores for MCEP teachers were in these categories: "apply scientific concepts" (19%), "use accurate scientific language" (25%), had a "comprehension of enduring understandings" (31%), or could "synthesize scientific concepts across courses" (31%)." On a second reading, 93.75% of the ePortfolios passed.
	ePortfolio: Science	Cohort 1a teachers (N=21)	None of the MISEP teachers' ePortfolios passed the first reading, 100% needed revision and resubmission. The lowest scores for MISEP were in these categories: "reflective practice" (38%), "comprehension of enduring content understandings" (43%), and "integration of available and appropriate technology into classroom practice" (38%)." On a second reading, 86.4% of ePortfolios passed.
47	Teacher interviews: Science	Cohort 2 teachers	Teachers' ratings of their understanding of science as "good" or "excellent" decreased by 3% between 2006-07 and 2007-08. However, teachers who rated their science skills as "good" or "excellent" increased by 10% between 2006-07 and 2007-08. Furthermore, teachers' ratings of their interest in science decreased by 1% between 2006-07 and 2007-08; yet ratings of teacher engagement in science increased by 4%, 2006-07 and 2007-08.
48	Content knowledge survey and follow-up test: Numbers and operations, geometry, and algebra	Cohort 1 participants (N=26)	During 2004-06, the mean numbers and operations scale score for Cohort 1 increased by .04 (not statistically significant), the mean geometry scale score increased by .24 (statistically significant at $p < .05$), and the mean algebra score decreased to -.01 (not statistically significant). During 2004-07, the mean numbers and operations scale score increased by .65 (statistically significant at $p < .05$), the mean geometry scale score increased by .25 (not statistically significant), and the mean algebra scale score increased by .29 (not statistically significant). During 2006-07, the mean numbers and operations scale score increased by .61 (statistically significant at $p < .05$), the mean geometry scale score increased by .01 (not statistically significant), and the mean algebra scale score increased by .30 (not statistically significant), 2004-07.
	Content knowledge survey: Mathematics	Cohort 2 participants (N=27)	Between 2005-07, the mean numbers and operations scale score for Cohort 2 increased by .21 points, the mean geometry scale score increased by .77 (significant at $p<.001$), and the mean algebra scale score increased by .17, 2005-07.
49	Content knowledge survey: Mathematics	Secondary School participants (N=78)	The mean scale score for arithmetic and algebra increased by .397; the mean geometry scale score increased by .192; and the mean overall scale score increased by .055. The results are statistically significant, 2007.
	Mathematics	Elementary School participants (N=84)	The mean scale score for number concepts and operations increased by .343; the mean scale score for geometry increased by .479; the mean scale score for patterns, functions, and algebra increased by .372; the mean overall scale score increased by .077. The results are statistically significant, 2007.
	Mathematics	Secondary School participants (N=81)	The mean arithmetic and algebra scale score increased by .168; the mean geometry scale score increased by .09; the mean overall scale score increased by .025. The results are statistically significant, 2006.
	Mathematics	Elementary School participants (N=93), except for Number Concepts and Operations (N=92)	The mean number concepts and operations scale score increased by .214; the mean geometry scale score increased by .200; the mean patterns, functions, and algebra scale score increased by .140 (not statistically significant); the mean overall scale score increased by .037. With the exception of the patterns, functions, and algebra score, the results are statistically significant, 2006.
	Mathematics	Secondary School participants (N=82)	The mean scale score for arithmetic and algebra increased by .110; the mean scale score for geometry increased by .191. The results were not statistically significant, 2005.
	Mathematics	Elementary School participants (N=90)	The mean scale score for number concepts and operations increased by .138; the mean scale score for geometry increased by .258; the mean scale score for patterns, functions, and algebra increased by .372; the mean overall scale score increased by .235. The results are not statistically significant, 2005.

Notes: Institute 46 has two other Cohorts of participating teachers; however, the results for these cohorts are not included in the local Institute evaluator's report because the degree program had not yet been completed. Institute 47 has a pre/post test; however, results were not available. Instead, the Institute measures changes in teacher perceptions of their own content knowledge.

Source: MSPs' annual and evaluators' reports; MSP-PE's site visit notes.

Exhibit 4

TEACHER SELECTION CRITERIA FOR PARTICIPATION IN INSTITUTE PARTNERSHIP ACTIVITIES

Institute No.	Experience	Certification	Course Completion	Ratings	Professional Status	Other Criteria
42	High school mathematics teachers	✓	N/A	N/A	N/A	N/A
43	Three years teaching	✓	N/A	Positive evaluation record for previous 3 years	N/A	N/A
44	Three years K-5 teaching	Full	Two graduate level math/leadership courses completed	GRE/MAT or equivalent	Exemplary math teachers	Successful interview, college transcript review
45	N/A	N/A	Partner graduate courses (alternative)	Individual assessment	N/A	Participation in prior NSF award (alternative)
46	N/A	N/A	N/A	N/A	N/A	From existing networks within district
47	Two years teaching K-8 science at least three times per week	N/A	Science background	N/A	N/A	Have principal's support; priority given to nearest schools, participation to extend beyond immediate area in succeeding years
48	Middle level math teaching	N/A	N/A	N/A	N/A	From high needs schools; selected as teams
49	Five years teaching	N/A	N/A	Leadership team screening	"Strongest" teachers; evidence of exemplary instruction and practice	Philosophy statement; review of applications; selected as teams of two lead teachers and one administrator

N/A= Not applicable
✓= Some level of certification is required to be an Institute participant.

Source: MSPs' proposals; MSPs' annual and evaluators' reports; MSP-PE's site visit notes.

Exhibit 5

TEACHERS PARTICIPATING IN THE MSP PROGRAM'S INSTITUTES (2003-2007)

Institute No.	Recruitment Objective(s)	Number of Teachers Recruited	Number of Teachers Retained			
			Cohort 1	Cohort 2	Cohort 3	Cohort 4
42	50 teachers	N/A	47 (includes non-MSP teachers)	25	32	29*
43	80 lead teachers	63**	30	26	N/A	N/A
44	50 elementary school teachers	54	25	27	N/A	N/A
45	6 Lead Teachers, 28 Master Teachers, 80 MST teachers, 132 Participating Teachers=246 total	20 Master Teachers***	17 Master Teachers	8 NSF teachers	13 NSF teachers	10 NSF teachers 50 Participating Teachers
46	16-20 teachers per cohort class	Cohort 1: 62 Cohort 2: 35 Cohort 3: 41 Cohort 4: 24	36	27	29	32
47	130 K-8 teachers	47 teachers recruited to participate in Cohort 2	24	29	N/A	N/A
48	122 middle level teachers	136	31	31	38	34
49	180 teachers (90 at elementary grade levels K-5, 60 at middle grade levels 6-8, and 30 at high school grade levels 9-12)	N/A	150 teachers in 87 schools			
TOTAL	878	482 (data are incomplete)	**TOTAL TEACHERS RETAINED:** 800 (may include double-counting)			

* Institute No. 42 Cohort 4 numbers may include Cohort 1 and 2 teachers.

**For Institute No. 43, 63 teachers have reportedly been served since the inception of the grant.

*** Institute No. 45 defines the term *NSF Teachers* (formerly called Master Teachers) as "those teachers participating in the Master's track," while *Participating Teachers (PT)* are "those who only attend the Summer Institutes and Pedagogy Conferences" (2007-08 Annual Report).

N/A= Data not available.

Source: MSPs' annual and evaluators' reports; MSP-PE's site visit notes.

Exhibit 6

CHARACTERISTICS OF TEACHERS AND STUDENTS IN SCHOOLS THAT SENT PARTICIPANTS TO THE MSP PROGRAM'S INSTITUTES

Characteristic	TEACHERS 2005-06 (n=8 projects)				STUDENTS 2005-06 (n=8 projects)	
	Mathematics Teachers		Science Teachers			
	No.	Percent	No.	Percent	No.	Percent
All	2,886	100.0	776	100.0	222,654	100.0
Gender						
Male	685	23.7	149	19.2	97,206	43.7
Female	2,195	76.1	411	53.0	93,823	42.1
Not identified	6	0.2	216	27.8	31,625	14.2
Race/ethnicity						
White	1,943	67.3	582	75.0	96,260	43.2
Black or African American	374	13.0	59	7.6	55,154	24.8
Hispanic	166	5.8	4	0.5	57,771	25.9
Asian	69	2.4	17	2.2	10,617	4.8
American Indian or Alaska Native	69	2.4	17	2.2	1,056	0.5
Native Hawaiian or Pacific Islander	5	0.2	5	0.6	268	0.1
More than one race	2	0.1	2	0.3	682	0.3
Not identified	325	11.3	107	13.8	846	0.4
Other						
National School Lunch Program participants	N/A	N/A	N/A	N/A	98,884	44.4
Special education students	N/A	N/A	N/A	N/A	16,112	7.2
Limited English proficient students	N/A	N/A	N/A	N/A	17,447	7.8

Notes: Does not add to 100% due to rounding.

Source: Hershey-Arista, M. et al., 2007. (Appendix E: Cohort 3 Institute Projects)

Exhibit 7

INSTITUTE LEADERSHIP FOCUS, BY LEVEL OF PARTICIPANT AND LEARNING COMMUNITY

Institute No.	Teacher Leadership	Administrator Training	IHE Faculty Training	Learning Community
42	Goal 2B. Developing Teacher Leaders	Goal 2A. Attaining Administrator Buy-in	Annual project leaders meeting	Administrators showed support for working with faculty from [partner IHE] in Math Inquiry Groups.
43	- Goal 1: Establish mathematics leadership programs at 40 high schools. - Goal 2: Establish lead mathematics teachers on participating campuses.	- Administrator Day during Summer Institute - Academic year workshops	Goal 9: Increase participating faculty, post-docs, and graduate students' understanding and awareness of instructional practices in public high schools.	Through interaction with classroom teachers in their classrooms and with their students, faculty, post-docs and graduate students will gain much insight into effective classroom practices.
44	"Goal 1: Prepare a group of 50 exemplary elementary school teachers to provide intellectual leadership as school-based Mathematics Specialists who combine: a profound understanding of the mathematics studied in the elementary grades; an enthusiasm for mathematics and its applications; the special knowledge needed for effective teaching of mathematics; and the leadership skills needed to serve as inspirations and resources for their peers and the mathematics education profession."	N/A	N/A	N/A
45	"Goal II. School District impact: enhance the competence and performance of in-service Middle Grade Mathematics teachers…to deliver quality mathematics education."	Presentations for principals	A key feature of [MSP] will be to develop the understanding and skills for college/university instructors to prepare future middle grade teachers effectively for their profession.	N/A

(Continued)

Exhibit 7 (Continued)

Institute No.	Teacher Leadership	Administrator Training	IHE Faculty Training	Learning Community
46	Goal 5 & 6: Teacher Leadership and Teacher Resource Support "As recommended by internal evaluators last year, we revised Benchmarks 5-1a and 5-1b (Teacher Leadership) to look for an annual increase in the number of acts of teacher leadership engaged in by participants..."	Administrators Academy: "The summer sessions again included an orientation to…programs and evaluation... [and] hands-on science lessons in which administrators served as students. Following the lessons, discussions of inquiry in the classrooms, as well as how to evaluate such lessons and support teachers learning to implement such lessons, were held… interactive sessions…on frameworks for school leadership, school culture and building professional learning communities [were provided]."	N/A	N/A
47	Goal 3. Produce leaders in the classroom, school, and profession	- Teachers participated in discussion with school and district administrators about science leadership strategies - Half day administrators roundtable and lunch session was conducted	Conducted regular monthly meetings of the science working group which includes Arts and Sciences Faculty.	Teachers participated in leadership discussions with school principals and curriculum specialists
48	Objective 1.2, Activity 2e: Support leadership opportunities for teachers…This should include speaking opportunities, inservice work, opportunities to be part of an instructional team, and opportunities to lead building-based school improvement activities.	N/A	N/A	N/A
49	Objective 6: Conduct Leadership Symposium	Lead teachers offered coaching to principals.	- Nearly all participating faculty…had opportunity to spend 3.5 days learning from 15 prominent national mathematics education leaders during the Leadership Seminar on Mathematics Professional Development. - Trainings during planning retreats were conducted	- Collegial Leadership Support - School Leadership - District Leadership Teams

N/A = Not applicable

Source: MSPs' annual and evaluators' reports; MSP-PE's site visit notes.

Exhibit 8

EVIDENCE OF TEACHERS' CONTRIBUTIONS TO DEVELOPING CHALLENGING OR ADVANCED COURSES

Institute No.	Evidence
42	Lead teachers, along with IHE faculty, developed and implemented a pilot of the *Jump Up to High School Math* program for students making the transition from middle school to high school mathematics in one partner district. The *Jump Up to High School Math* program also featured a professional development component for teachers.
43	Two Cohort 1 lead teachers served as content developers and instructors for leadership activities during the 2007 Summer Leadership Institute. For the 2008 Summer Leadership Institute, two [MSP] lead teachers who are certified master mathematics teachers were separately responsible for major components of the leadership strand (classroom management and case studies).
44	The management team, along with IHE mathematicians, mathematics educators, and mathematics supervisors in K-12 schools, developed the mathematics and leadership courses…these core members decided to collaborate on curriculum development for the summer institutes and training teachers to become mathematics specialists in the partner school districts. The [MSP] primarily provides content-intensive summer institutes and master's degree programs for mathematics teachers interested in becoming mathematics specialists, which develops content, pedagogy, and leadership skills.
45	One faculty and two teacher leaders taught each course but teacher leaders only assisted the faculty in delivering the courses and workshops during the summer institutes. However, they played a critical role in translating the mathematical content into a "pedagogical, practical, and usable approach." The teachers in the project have provided invaluable input and feedback about the functionality of the software, which has contributed tremendously to upgrades that make the software training more accessible to the middle school teachers nationwide.
46	Co-instruction of Summer Institute courses.
47	Participating teachers played a role in facilitating course discussion.
48	Preservice and inservice courses were developed, but with no mention of input from teachers, although master teachers were part of course teaching teams.
49	Master K-12 mathematics instructors worked with IHE mathematics faculty (Disciplinary Content Team) to develop and implement the six content courses offered in the Summer Institute. "Each Disciplinary Content Team has at least four members, including at least three university/community college disciplinary faculty members and one K-12 master teacher." Collegial Leadership Team—"This group of K-12 master teachers, university educators, and administrators work through Teachers Development Group to develop and facilitate the Collegial Leadership in Mathematics (CLM) component of the summer institutes."

Source: MSPs' annual and evaluators' reports; MSP-PE's site visit notes

Exhibit 9

COMPARISON OF ACADEMIC YEAR ACTIVITIES UNDERTAKEN BY IHE FACULTY AND ADMINISTRATORS, BY MSP TYPE

Activity	INSTITUTES 2004-05 (n=93 faculty/admin.) No.	Percent	INSTITUTES 2005-06 (n=96 faculty/admin.) No.	Percent	COMPREHENSIVE AND TARGETED MSPs 2004-05 (n=103 faculty/admin.) No.	Percent	COMPREHENSIVE AND TARGETED MSPs 2005-06 (n=101 faculty/admin.) No.	Percent
					Activities targeted to multiple K-12 teachers			
1. Conduct workshops/*institutes*/courses with K-12 teachers that increase *general* content and/or pedagogical knowledge	26	28.0	38	39.6	48	46.6	47	46.5
2. Conduct targeted workshops/*institutes*/courses with K-12 teachers	10	10.8	15	15.6	23	22.3	31	30.7
3. Facilitate online course(s) for participants	10	10.8	15	15.6	--	--	--	--
4. Establish/provide STEM [in-person or online] learning communities/study [groups]	12	12.9	21	21.9	17	16.5	20	19.8
5. Provide mentoring for teacher leaders related to their leadership responsibilities	18	19.4	18	18.8	--	--	--	--
6. Provide instruction for teacher leaders related to their leadership responsibilities	9	9.7	13	13.5	--	--	--	--
7. Work with K-12 building staff to facilitate the work of the teacher leaders	10	10.8	18	18.8	--	--	--	--
					Activities targeted to individual K-12 teachers			
8. Establish/provide externship opportunities for K-12 teachers	1	1.1	2	2.1	13	12.6	11	10.9
9. Remain “on call” for classroom teachers	29	31.2	45	46.9	24	23.3	34	33.7
10. Support adjunct positions for K-12 master teachers at IHE	6	6.2	6	6.3	10	9.7	10	9.9
11. Help K-12 teachers utilize technology for course content innovation	11	11.8	22	22.9	32	31.1	30	29.7
12. Increase collaborative activities with regional school systems to improve K-12 instruction and learning	17	18.3	16	16.7	--	--	--	--
13. Strengthen IHE’s preservice activities	22	23.7	26	27.1	--	--	--	--
14. Establish a new/modified degree or certification program	18	19.4	18	18.8	--	--	--	--
15. Engage department in activities to improve K-12 instruction and learning	25	26.9	27	28.1	--	--	--	--
16. Other	3	3.2	6	6.3	--	--	--	--

Notes: Eight MSPs reporting. Responses include double-counting. Italics denote activities conducted by Comprehensive and Targeted projects only. Brackets denote wording included in the Institute data only. Percents add to more than 100 because some respondents reported more than one activity. “--” signifies no data reported for Comprehensive and Targeted MSPs for this activity.

Source: Hershey-Arista, M. et al., 2007.

Exhibit 10

PLANNING AND DEVELOPMENT ACTIVITIES UNDERTAKEN BY IHE INSTITUTE FACULTY AND ADMINISTRATORS

Activity	2004-05 (n=93 faculty/admin.)		2005-06 (n=96 faculty/admin.)	
	No.	Percent	No.	Percent
Assess District Needs				
Collaborate with other IHE faculty to establish K-12 district needs, Institute mission, and goals	67	72.0	45	46.9
Collaborate with school district stakeholders to establish K-12 district needs, Institute mission, and goals	42	45.2	33	34.4
Conduct fact-finding activities to inform Institute curriculum development	41	44.1	26	27.1
Align Efforts with Standards and Curricula				
Align Institute curricula with other courses/standards	56	60.2	41	42.7
Align curricula with recent research about mathematics and science pedagogical methods	61	65.6	47	49.0
Link the institute work to national teacher certification activities or advanced degree completion	46	49.5	31	32.3
Implement Plans				
Enlist expert individuals external to the MSP management to act as an advisory committee	28	30.1	15	15.6
Recruit graduate students to assist with Institute planning and instruction	29	31.2	22	22.9
Establish requirements for teacher leader participants	38	40.9	23	24.0
Conduct district/school/teacher recruiting activities	41	44.1	25	26.0
Select teacher leaders	27	29.0	18	18.8
Other	22	23.7	12	12.5

Notes: This table only includes information for IHE faculty and administrators who spent more than 40 hours on their own MSP during a given school year. Percents add to more than 100 because some respondents reported more than one activity.

Source: Hershey-Arista, M. et al., 2007. (Appendix E: Cohort 3 Institute Projects)

Exhibit 11

SUMMER ACTIVITIES UNDERTAKEN BY IHE INSTITUTE FACULTY AND ADMINISTRATORS

Activity	2004-05 (n=93 faculty/admin.)		2005-06 (n=96 faculty/admin.)	
	No.	Percent	No.	Percent
Teach courses with K-12 teachers that increase mathematical or science content knowledge	57	61.3	48	50.0
Teach courses with K-12 teachers that increase pedagogical skills in mathematics and science	52	55.9	44	45.8
Teach targeted courses with K-12 teachers on mathematical or science content knowledge or pedagogical skills	20	21.5	16	16.7
Teach targeted courses with K-12 teachers that improve leadership skills and strategies	29	31.2	22	22.9
Teach courses with K-12 teachers that increase abilities to develop new and challenging curriculum materials	42	45.2	33	34.4
Teach courses with K-12 teachers on working with adult learners	9	9.7	8	8.3
Teach courses with K-12 teachers that increase understanding of how to use technology for course content innovation	27	29.0	23	24.0
Teach courses with K-12 teachers using data and research to inform teaching	31	33.3	26	27.1
Teach courses for school administrators	6	6.5	5	5.2
Teach courses through distance learning	8	8.6	5	5.2
Team-teach courses with K-12 teachers	30	32.3	26	27.1
Provide mentoring for teacher leaders on professional development strategies and other leadership responsibilities	20	21.5	19	19.8
Involve graduate students in Institute course instruction	29	31.2	28	29.2
Direct or organize enrichment activities during summer Institute	22	23.7	25	26.0
Other	10	10.8	2	2.1

Source: Hershey-Arista, M. et al., 2007. (Appendix E: Cohort 3 Institute Projects)

Exhibit 12

COMPARISON OF FIELD OF RESEARCH AND INSTRUCTION FOR IHE FACULTY AND ADMINISTRATORS, BY MSP TYPE

Field of Research and Instruction	INSTITUTES				COMPREHENSIVE AND TARGETED MSPs			
	2004-05 (n=102)		2005-06 (n=103)		2004-05 (n=116)		2005-06 (n=125)	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Field of Research								
Education	42	41.2	45	43.7	55	47.4	44	35.2
Mathematics	30	29.4	24	23.3	25	21.6	25	20.0
Science	12	11.8	13	12.6	26	22.4	39	31.2
Biological sciences	0	0	0	0	5	4.3	10	8.0
Chemistry	7	6.9	7	6.8	2	1.7	7	5.6
Physics	3	2.9	3	2.9	5	4.3	3	2.4
Engineering	0	0	0	0	8	6.9	12	9.6
Geosciences	1	1.0	2	1.9	4	3.4	4	3.2
Astronomy	1	1.0	1	1.0	0	0	1	0.8
Computer science	0	0	0	0	1	0.9	0	0
Ocean sciences	0	0	0	0	1	0.9	2	1.6
Other	9	8.8	11	10.7	6	5.2	10	8.0
N/A	9	8.8	10	9.7	4	3.4	7	5.6
Field of Instruction								
Mathematics	49	48.0	44	42.7	39	33.6	31	24.8
Education	28	27.5	33	32.0	36	33.0	36	28.8
Science	17	16.7	18	16.5	34	29.3	45	36
Biological sciences	1	1.0	1	1.0	6	5.2	10	8.0
Chemistry	9	8.8	9	8.7	5	4.3	10	8.0
Physics	4	3.9	6	5.8	8	6.9	4	3.2
Geosciences	1	1.0	1	1.0	5	4.3	4	3.2
Engineering	0	0	0	0	10	8.6	15	12.0
Astronomy	2	2.0	1	0	0	0	1	0.8
Computer science	0	0	0	0	0	0	0	0
Ocean sciences	0	0	0	0	0	0	1	0.8
Other	3	2.9	4	3.9	3	2.6	6	4.8
N/A	5	4.9	4	3.9	4	3.4	7	5.6

N/A= Not applicable.

Notes: Atmospheric sciences has been omitted as both a field of research and a field of instruction due to no reported data.

Source: Hershey-Arista, M. et al., 2007.

Exhibit 13

COMPARISON OF HOURS OF INVOLVEMENT FOR IHE FACULTY AND ADMINISTRATORS, BY MSP TYPE

	INSTITUTES				COMPREHENSIVE AND TARGETED MSPs			
	2004-05 (n= 102 faculty/admin.)		2005-06 (n=103 faculty/admin.)		2004-05 (n=116 faculty/admin.)		2005-06 (n=125 faculty/admin.)	
Hours of Involvement	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**
Less than 20	3	2.9	3	2.9	7	6.0	11	8.8
20 to 40	6	5.9	4	3.9	6	5.2	13	10.4
41 to 80	9	8.8	17	16.5	18	15.5	8	6.4
81 to 160	15	14.7	17	16.5	18	15.5	26	20.8
161 to 200	15	14.7	12	11.7	12	10.3	14	11.2
More than 200 hours	54	52.9	50	48.5	55	47.4	53	42.4

Note: Does not add to 100% due to rounding.

Source: Hershey-Arista, M. et al., 2007.

Exhibit 14

MSP PROFESSIONAL DEVELOPMENT MATRIX: PERCENTAGE OF MSPs ACCORDING TO FOCUS

Type of Professional Development	Individual Focus			
	Classroom Teacher	**Lead Teacher/ Master Teacher**	**Principal, Assistant Principal, or Administrator**	**Learning Community**
Preservice	6 of 11 comprehensive **54.5%** 9 of 30 targeted **30%** 1 of 8 Institutes **1.25%** SUBTOTAL: 16	N/A	N/A	N/A
Inservice	11 of 11 comprehensive **100%** 20 of 30 targeted **66.7%** 3 of 8 Institutes **37.5%** SUBTOTAL: 34	2 of 11 comprehensive **18.2%** 7 of 30 targeted **23.3%** 3 of 8 Institutes **37.5%** SUBTOTAL: 12	4 of 11 comprehensive **36.4%** 10 of 30 targeted **33.3%** 2 of 8 Institutes **25%** SUBTOTAL: 16	1 of 11 comprehensive **9.1%** 6 of 30 targeted **20%** 2 of 8 Institutes **25%** SUBTOTAL: 9
TOTAL	**50**	**12**	**16**	**9**

Note: Total adds to more than 48 as a result of MSPs providing more than one type of professional development.

N/A = Not applicable

Source: MSPs' annual and evaluators' reports; MSP-PE's site visit notes

Exhibit 15

FACTORS THAT HINDERED INSTITUTE PARTNERSHIPS' EFFORTS TO A MODERATE OR LARGE EXTENT

Factor	2004-05 (n=8 projects)		2005-06 (n=8 projects)	
	No.	Percent	No.	Percent
Time				
Lack of time or other resources among IHE partners	2	25.0	1	12.5
Lack of time or other resources among K-12 partners	2	25.0	2	25.0
Lack of time or other resources among other partners	0	0.0	0	0.0
Commitment				
Low levels of commitment or interest among IHE partners	0	0.0	0	0.0
Low levels of commitment or interest among K-12 partners	2	25.0	3	37.5
Low levels of commitment or interest among other partners	0	0.0	0	0.0
Flexibility				
Lack of flexibility among IHE partners	1	12.5	0	0.0
Lack of flexibility among K-12 partners	2	25.0	4	50.0
Lack of flexibility among other partners	0	0.0	0	0.0
Turnover				
Personnel turnover within K-12 partner organizations	3	37.5	3	37.5
Personnel turnover within other organizations	0	0.0	1	12.5
Interpersonal Conflicts				
Poor communication among all MSP partners	1	12.5	0	0.0
Unbalanced levels of authority and decision making ability among partners	2	25.0	2	25.0
Conflicting goals or missions among MSP partners	0	0.0	1	12.5

Note: Does not add to 100% due to rounding.

Source: Hershey-Arista, M. et al., 2007. (Appendix E: Cohort 3 Institute Projects)

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