WORKING
PAPER

Math Science Partnership of Southwest Pennsylvania

Year Two Evaluation Report

VALERIE L. WILLIAMS
JOHN F. PANE
CYNTHIA A. TANANIS
STUART S. OLMSTED

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RAND EDUCATION

Preface

In fiscal year 2002, the National Science Foundation (NSF) launched the Math and Science Partnership program. This program builds on the nation's dedication to educational reform by supporting partnerships that unite the efforts of K-12 school districts with science, mathematics, engineering, and education faculties of colleges and universities. This program has made 79 awards with $419 million awarded to date. The Math Science Partnership of Southwest Pennsylvania (MSP) is one of seven comprehensive partnership projects funded by NSF in 2003. This MSP brings together 48 K-12 school districts, 40 as part of the NSF grant as well as eight additional districts supported by a companion Math Science Partnership grant from the Pennsylvania Department of Education, four Intermediate Units (IUs), four Institutions of Higher Education (IHEs), and other strategic partners in Southwest Pennsylvania. The goals are to increase K-12 students' knowledge of mathematics and science; increase the quality of the K-16 educator workforce; and create a sustainable coordination of partnerships in the IUs. The MSP is housed at the Allegheny Intermediate Unit (AIU), in Homestead, Pennsylvania near Pittsburgh. AIU subcontracted with the RAND Corporation and the University of Pittsburgh to serve as the project's evaluation team. The project and the evaluation commenced in September 2003.

The evaluation investigates the effectiveness of the partnership, its impact on institutional practices and policies at partner educational institutions, changes in math and science instruction, and changes in student course taking and outcomes. Over the course of the project, data will be collected from numerous sources to address these points, including focus groups and interviews of key project personnel, surveys of principals and math and science teachers, case studies in partnership school districts, documentation of partnership meetings and activities, artifacts produced by the partnership, math and science achievement data for K-12 students, and course completion data for K-12 and IHE students.

This working paper is based on information collected from the project's start in September 2003 through mid-May 2005. It provides a baseline description of the partners and a formative assessment of the project's progress and challenges. It is the second in a series of annual evaluation reports that the Assessment and Evaluation Team will provide to AIU, which partially fulfill AIU's larger annual reporting requirements to the NSF.

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Summary

The National Science Foundation's (NSF) Math and Science Partnership program seeks to improve student learning in mathematics and science through the attainment of the following goals: provide a challenging curriculum for every student; increase and sustain the number, quality, and diversity of teachers of mathematics and science from kindergarten to grade 12 (K-12) through further development of a professional education continuum; contribute to the national capacity to engage in large-scale reform through participation in a network of researchers and practitioners; and engage the learning community in the knowledge base being developed in current and future NSF Centers for Learning and Teaching and Science of Learning Centers. Previous NSF programs targeting math and science educational reform have had similar goals. However, the Math and Science Partnership program is notable in its requirement that higher education be included as a partner, playing a critical role in the K-12 educational reform. Each Math and Science Partnership must include one or more school districts and one or more higher education entities as core partners, with additional partners encouraged, but not required. Moreover, the Math and Science Partnership program expects full participation from mathematicians, scientists and engineers in this effort. The NSF also expects substantial institutional change to occur at both the K-12 and institution of higher education (IHE) levels and plans to study partnership models to learn how partners' commitments result in institutional changes that will lead to the scalability and sustainability of their efforts.

The program supports two types of partnerships, *comprehensive* and *targeted*. Comprehensive projects are funded for a five-year period for up to $7 million annually, depending on the scope of the project. These projects are intended to implement change in mathematics and/or science education in both IHEs and school districts, resulting in improved student achievement across the K-16 continuum. Targeted projects focus on improved K-12 student achievement in a narrower grade range or disciplinary focus in math or science and are funded for up to $2.5 million per year for up to five years. In addition, the Math and Science Partnership program funds research, evaluation, and technical assistance projects that build and enhance large-scale research and evaluation capacity for all Math and Science Partnership awardees and provide them with tools and assistance in the implementation and evaluation of their work.

The Math Science Partnership of Southwest Pennsylvania (MSP) is one of seven comprehensive partnership projects funded by NSF in 2003. It is a partnership of 48 school districts, four institutions of higher education (IHEs), and four regional educational service agencies known as Intermediate Units (IUs). The NSF award supports 40 of the school districts, and a Math and Science Partnership award from the Pennsylvania Department of Education (PDE) supports the remaining eight. The MSP is headquartered at the Allegheny Intermediate Unit (AIU), the central IU representing also the greatest density of school districts in the region. The region includes the urban fringe of the City of Pittsburgh, several smaller urban areas, suburbs, and rural areas. Total enrollment in the MSP school districts is approximately 114,000 students, with approximately 3,800 teachers who teach math or science topics.

Consistent with the objectives of the overall Math and Science Partnership program, the primary goals of this partnership are to increase K-12 students' knowledge of mathematics and science; increase the

quality of the K-16 educator workforce; and create a sustainable coordination of partnerships in the IUs, building intentional feedback loops between K-12 districts and IHEs, tapping the discipline-based expertise of the IHEs, and improving the mathematics and science learning experiences for all undergraduates.

The MSP plans to accomplish these goals through three crosscutting intervention strategies:

- *Professional Development for Leadership* is accomplished through academies and seminars for K-12 educators and IHE faculty. The overriding purpose of these activities is to equip teachers with the pedagogy, content, and leadership skills necessary to become effective leaders in their institutions.

- *Curriculum alignment and pedagogical and course refinement* is accomplished at the K-12 level through the use of curriculum frameworks, and at the IHE level through the contributions of teachers who spend one to two semesters or a summer on the campuses.

- *Support for and dissemination of research based resources and tools* is primarily accomplished through conferences and networks of educators using research-based curricula.

Within each strategy are a variety of planned activities that collectively comprise the overall project implementation plan. This highly detailed implementation plan contains hundreds of action steps across the teams and staff of the MSP. Over the life of the project, the strategies are expected to remain in place, even if the specific activities included within each strategy may change and/or shift in priority.

Project Evaluation and Purpose of this Report

The AIU subcontracted with the RAND Corporation and the University of Pittsburgh to serve as the project's evaluation team. The evaluation is designed to monitor annual progress in order to offer formative advice to the project, to measure its ultimate success in achieving its goals, and to document how well the model worked for the benefit of future initiatives that may seek to replicate it. The project and the evaluation commenced in September 2003. The project evaluation will address four research questions:

1. Have MSP partners developed and implemented a comprehensive intervention targeting math and science curriculum and achievement? If so, how?

2. Have institutional practices and support structures changed at K-12 districts and IHEs participating in the MSP? If so, how?

3. Have math and science instruction changed in K-12 districts participating in the MSP? If so, how?

4. In what ways have student outcomes and course taking changed in K-12 schools and districts implementing the MSP? If change occurred, what is the connection between implementation of the MSP plan and these changes?

This report is the second in a series of annual evaluation reports detailing the evolution of the Math Science Partnership of Southwest Pennsylvania. The primary purpose of this report is to provide formative assessment of activities to date. The following sections summarize data gathered to date related to each of the four research questions.

Intervention Strategies

This section discusses the major activities within each of the three intervention strategies, along with relevant findings from the Year Two evaluation.

Professional Development for Leadership

<u>Leadership Action Academies</u>

The Leadership Action Academies (LAAs) are one of the key activities for building leadership capacity within each district. Leadership Action Teams (LATs) represent each school district and IHE. Each team assesses strengths and weaknesses in its institution and develops an action plan for improvement. The teams select teachers and administrators to participate in the other MSP activities. District LATs meet collectively four times per year in the Leadership Action Academies, and IHE LATs meet as necessary on their campuses.

The LAAs were well-attended and supported by the districts. During Year Two, the LAAs met and included representation from 47 of the 48 MSP districts. While most teams had attendance by the majority of team members, a few districts had fewer LAT members present due to scheduling conflicts or the inability of school and district administrators to be away from their districts for extended periods. IHE LATs meet as needed for planning and development purposes. One of the activities of each K-12 and IHE LAT was to place its institution on a Development Matrix, an instrument based on the Concerns Based Adoption Model (Loucks-Horsley & Stiegelbauer, 1991), to reflect the stage of the institution's transition in the adoption and implementation of challenging courses and curricula. K-12 districts indicated a positive change across all levels (elementary, middle, and secondary) and content areas (math and science) from Year One to Year Two of the project.

<u>Teacher Leadership Academies</u>

The teacher leadership academies (TLAs) are one of the primary professional development activities for cultivating teacher leaders. The TLAs provide leadership development for selected teachers, grouped by discipline and level (elementary math, secondary math, and 9^{th}-12^{th} grade science). Trainings will occur over a two-year period, totaling 20 days: five days each summer and five days during each school year. The teacher leaders are expected to go back to their school districts and develop "communities of learning," sharing what they learned in the academies with fellow teachers during on-site professional development in their own districts.

During Year Two, TLAs were completed for elementary and secondary math and high school science involving 182 teacher leaders representing 38 of 40 NSF MSP districts. The higher education partners sponsored the TLAs on their campuses and provided opportunities for involvement by math, science, and education faculty. The partner IUs host school-year follow-up sessions of the TLAs. Participants, as well as the presenters/facilitators, evaluated each academy to enable refinement in subsequent academies. Responses from participating teachers were generally positive. Follow-up sessions enabled teacher leaders to address specific challenges they encountered implementing the on-site academies in their home schools. District case study findings indicate a number of difficulties in implementing the on-site workshops. Although districts nominally had committed to 24 hours of professional development for their teachers via the on-site academies, competing priorities often jeopardized the actual scheduling and content of the professional development. Teacher leaders can be placed in a difficult situation if a supervising administrator usurps the professional development time and/or agenda. Participation and implementation data are being more closely examined to determine the full extent of these issues and to explore potential avenues to address them.

Lenses on Learning

Lenses on Learning (LoL) is a training seminar for district principals to build a deeper understanding of effective mathematics instruction, and develop effective observing and conferencing techniques. These sessions total 38 hours over a one-year period. The MSP has supplemented this seminar with an additional module to support science education supervision as well. LoL is designed to provide an administrative infrastructure within the region for math and science reform. Similar to the TLAs, which are designed to inform teacher leaders about appropriate pedagogy and support for communities of learners in schools (both students and teachers), LoL has as its aim a deeper level of understanding of reform and the ways in which it can be supported by principals and other administrators.

LoL was a very successful MSP activity in Year Two. Participants reported high levels of satisfaction and rate it among the best professional development they have received. In our principal survey, we observed some differences between principals who participated in LoL and principals who did not. Although our analysis cannot definitively link these differences to participation in LoL, the trend looks promising. Our follow-up principal survey will continue to monitor the influence of LoL. In recognition of the importance of building administrative capacity to support the project, the MSP has identified LoL as a required "on-ramp" for expansion districts planning to join the project in Year Three.

Curriculum Alignment and Pedagogical and Course Refinement

Math and Science Curriculum Frameworks

The MSP developed a curriculum framework for science, and refined one for math, with the six to eight big ideas to be taught in these disciplines at each grade level (K-12). The frameworks are intended to help make effective teaching of Pennsylvania's academic standards in science and math manageable, by enabling teachers to focus on teaching fewer concepts in more depth.

As the project moved into its second year, the focus shifted from development of the frameworks to their utilization within MSP strategies and activities, such as the TLAs, on-site academies, and *Lenses on Learning*. MSP staff report that the frameworks continue to serve as useful resources and tools for aligning curricula. The Pennsylvania Department of Education recently developed a set of math assessment anchors to help align curriculum, instruction and assessment practices, so the Math Framework was refined this year to include these anchors. Additionally, in the course of creating the Science Framework, the project developed a set of grade level expectations, which are a resource to the PDE as it develops an official set of assessment anchors for science. This is one example of the evolving nature of the MSP project and the expected and planned shifting of emphasis across resources, strategies, and activities as the project matures. This evolution is an important component of long-term sustainability.

Teacher Fellows

The Teacher Fellow (TF) program provides support for two teachers from each district over the five-year grant period to spend one or two terms at a partner IHE. The intent of the program is two-fold: to build a bridge for relationships between K-12 and IHE that will benefit both institutions, and to serve as a form of professional development for the TF. TFs refine and revise IHE courses, and enroll in IHE courses to deepen their own math or science content knowledge.

The TF program began in the summer of 2004. During Year Two, we noted that TF program has tremendous potential for sustainable relationships that build on mutual benefit, such as co-authoring peer-reviewed articles, forming stronger connections between the IHE and K-12 school districts through targeted interactions between K-12 teachers and IHE faculty, and facilitating discussions in IHE departments about how best to teach future K-12 educators. Regarding course revision by TFs, some faculty questioned the value of mapping state standards to their courses. Getting buy-in from IHE faculty for this idea has been a problem since the inception of the grant due, in part, to the culture of independent course development and teaching in a higher education institution; the IHE team leaders have each tried various means to get faculty on board. In addition, faculty reported that some TFs do not have the disciplinary background to benefit from the college courses. In one case, the IHE team leader recognized that the TF was not able to fully participate in his/her enrolled class, and allowed the TF to drop the class to take an independent study with another faculty member on a topic of interest. This highlights the importance of being able to tailor the experience for each TF.

Support for and Dissemination of Research-Based Resources and Tools

Network Connections

The Network Connections meetings are daylong conferences held twice a year, for Leadership Action Teams and other math and science teachers and IHE faculty to explore resources and tools. Representatives from school districts throughout the 11-county southwest Pennsylvania region come together with representatives of universities, corporations and non-profit organizations. All of the 141 school districts in the region are invited to participate. District representatives, including teachers, principals, and other administrators such as technology or curriculum coordinators attend sessions relevant to math and science instruction at the K-12 levels.

Network Connections sessions during Year Two were well received by participants. Evaluation findings indicated very high ratings across all sessions and meeting components. A number of participants indicated that gaining exposure to current research findings and other resource information, along with the opportunity to meet as an institutional team, makes Network Connections a valuable resource to participating district teams.

Journal and *Coordi-net* Publications

The *Journal* and *Coordi-net* are sister publications distributed annually to all math and science teachers in schools throughout the 11-county area. The *Journal* is the larger of the two and offers reports of activity, new developments, and lessons learned in addition to an A to Z resource directory of professional development opportunities available to support math and science education. For example, notices about TLAs, LAAs, Network Connections, and Content Deepening Seminars are provided with details for registration. The *Coordi-net* serves as a mid-year update on professional development opportunities available in the spring and summer, as a supplement to the *Journal*.

During Year Two these resources were published and distributed as planned. Project staff received reports of increased use of these resources by MSP project schools as a communication vehicle. The MSP has received increased feedback and requests for additional copies of these publications during Year Two. However, even with concerted efforts, including fax back forms and follow up phone calls, distribution of the publications to math and science teachers can be unreliable due to a variety of distribution systems determined and controlled by individual districts. This was further exacerbated when difficulties with the publisher resulted in late delivery of the *Journal* into schools this year.

Institutional Practices and Support Structures

A key feature across all MSP projects is partnership development, and the institutional practices and support structures that facilitate partnership. At the level of the Math and Science Partnership program, NSF places a considerable emphasis on partnership between K-12 districts and IHEs. Additionally, at the project level other partnerships are important, such as those among science, math and education faculty within IHEs; among faculty across IHEs; among IUs; among K-12 districts; and between IUs and K-12 districts. During Year Two, we observed that most of these partnerships are evolving. Substantial progress has been made, however changes in institutional structures and practices may be necessary to fully realize the potential of these partnerships. We briefly discuss the nature of these partnerships and the extent to which the partnerships have demonstrated growth during Year Two.

Partnerships Across and Within IHEs

There has been some interaction among faculty across IHEs, particularly among team leaders and project directors, but individual faculty reported in interviews that they would have preferred to have more direct interaction with faculty at other IHEs. To varying degrees, math, science and education faculty reported the development of partnerships among faculty within an IHE, either between math and science faculty, or between education and math or science faculty. However, within an institution, the degrees of partnership varied from strong to virtually non-existent across these groups. In many cases, these partnerships existed prior to the MSP project and continued participation in MSP activities has strengthened these connections. The strongest cases of partnership appear to exist in the IHEs where education faculty are members of the disciplinary department (for example, where math education faculty are members of the math department). In IHE interviews, discipline faculty members reported they are working with education faculty on courses, and in one case, collaborating to publish an article about the MSP.

Partnerships Between IHEs and K-12 Districts

The Teacher Leadership Academies and the Teacher Fellow program provided the first substantial opportunities for partnership building between K-12 school districts and IHEs. These were the first MSP activities in which a large number of IHE faculty directly interacted with K-12 teachers. In both of these activities, some groundwork has been laid for the partnerships.

Partnerships Between K-12 Districts and Between IUs

As a result of participating in MSP activities, teachers from different districts have more opportunities to interact, which has led to increased partnership among the schools and districts. Teachers on LATs not only work with teachers within their districts, but also exchange ideas with teachers and administrators from other districts in LAA sessions that bring together team members who are teachers of math or science at similar grade levels. A similar kind of interaction occurs among LAT administrators. The TLAs, both during the summer and in the follow-up sessions during the school year, bring teacher leaders together from different districts, affording opportunities to share ideas and resources. Network Connections also provides opportunities for teachers from various districts to interact, and, finally, the Educator Networks, which are focused on specific curricula such as Everyday Math, bring teachers from different districts together to network and share ideas. These last two examples of K-12 partnership building also include additional districts that are not involved in the MSP. After having experienced these activities, some of the teachers from non-MSP districts are now lobbying for their districts to join the MSP as part of the project's planned expansion in Year Three. Finally, a partnership is being built among the IUs. The MSP is housed at AIU, but the districts involved in the MSP are from six different IUs.

Math and Science Instructional Practices

Our survey of teachers gathered baseline data on teacher instructional practices and some of the factors that influence them, including preparation, assessments, and activities. In addition, our principal survey included a number of items designed to elicit principals' perspectives on these topics. Below are some of the patterns we observed:

- For a number of classroom preparation items, K-8 teachers of science consistently indicated they are less well prepared than other subgroups of teachers (K-8 teachers of math, high school math teachers, and high school science teachers).

- High school teachers of math and science appear to be very confident in most aspects of instructional preparation, such as teaching math or science at the assigned level and providing math or science instruction that meets content standards.
- As a subgroup, high school math teachers are less likely than the other subgroups to report they use performance tasks, such as hands-on activities, to assess student progress on a weekly basis. Conversely, high school math teachers are more likely than other teachers to report using short answer questions weekly.
- K-8 teachers of math had the greatest percentage of teachers reporting that district and state tests are strong positive influences on instruction. However, many principals reported they do not find state testing policies encourage effective instruction.
- Overall, across all grade levels and subject areas, we found that even prior to participating in MSP workshops and seminars, teachers reported they spend a considerable amount of classroom time engaging in the activities that are promoted and encouraged by the MSP professional development, and principals are generally supportive of these practices.

Student Outcomes

At baseline we observed several notable characteristics of MSP schools. NSF MSP schools generally outperform statewide averages, and the PDE MSP schools generally under-perform the statewide averages. MSP schools represent a broad range of student demographics. Some schools have student populations that typically do not perform very well on the PSSA, Pennsylvania's standardized test, while other schools have student populations that typically perform quite well. When compared to peers with similar demographics MSP schools represent a mix of schools; some that under-perform their peers, and some that over-perform their peers. Finally, our sample of case study districts captures the range of variance on each of these dimensions.

Conclusions

Several themes emerged from our analysis of the Year Two findings, which we believe are important to the continued achievement and sustainability of the partnership. We also list some questions that reflect our thinking about next steps and may assist the MSP in its strategic planning for Year Three.

Building capacity in schools that are most challenged

As indicated through initial case study data, some of the lowest implementing districts are also among the most challenged by educational burden and least equipped with existing capacity to support reform. This finding is not surprising and is documented in many reform and improvement initiatives. However, the MSP seeks to address schools across the spectrum of educational need and resources. As noted earlier, even in higher implementing schools, a key variable seems to be administrative leadership with a philosophical "buy-in" that leads to active support. This support seems especially tentative in these low implementing districts. Questions for the MSP to consider include: Are different strategies and/or approaches needed for these districts? If so, what are they? Are the key leverage points different in these districts?

Clearly communicating intent and rationale

Communication is a key issue in a project as large and complex as the MSP. During the first year, MSP partners all had to come together and understand a common conceptual "language" regarding the MSP. This appears to have been successful with partners developing increased fluency. Core communication issues now center on clearly communicating intent and rationale, and as an outgrowth of these, roles and expectations. This issue is most apparent with individual IHE faculty, although it is possible that other partners have similar concerns. Our questions are: How can the MSP ensure that all participants understand their roles and responsibilities? How can the MSP best utilize all partners in planning and delivering MSP activities?

Linking the student teacher pipeline between K-12 and IHEs

An important strategy to leverage the capacity being built by the MSP in K-12 schools is to ensure that student teachers are exposed to the communities of teacher leaders being developed in K-12 settings. This can be accomplished by placing student teachers with MSP-participating teachers. This will afford student teachers opportunities to be mentored on the implementation of reform-oriented teaching strategies and to be fully supported in their first experiences implementing them. These student teaching experiences will help to improve the pipeline of new teachers feeding into MSP schools and other schools in the region, thus building the capacity of highly qualified teachers in southwest Pennsylvania. IHE faculty indicate they are convinced of the benefits of this synergy, and are working to enact it; however, thus far the strategy has met with only limited success. District administrators and students themselves often have discretion over student teacher placements and can undermine this strategy. Moreover, IHE faculty often have little influence over student teacher placement, as it is handled by a staff person or administrator. For the strategy to fully succeed, more integrated and focused management of student teacher assignments will be needed. What can the MSP do to help all parties in the decisions about student placements become aware of and vested in enacting this placement strategy?

Balancing competing or conflicting incentives between K-12 and IHE

K-12 teachers and IHE faculty face a number of challenges to full participation in the MSP project. For example, the incentive/reward structures of these two partners are not well aligned. In IHEs, faculty members are rewarded for their publication records. Participating in projects such as the MSP may be viewed as a distraction from the primary role of faculty. The potential positive impact of the MSP on IHE teaching practices is not widely recognized or is undervalued. Because IHE faculty are likely to consider themselves experts in their content areas, they show little commitment to considering K-12 standards in their courses. The collective cultural differences and potential disincentives may make partnership and true collaboration very difficult to build and sustain. We ask: What can the MSP do to help partners better understand and accommodate each others' cultural norms and expectations? How can the strengths from each community be considered as models for the other? How can the MSP assist in encouraging sustained partnerships between IHE faculty and K-12 teachers where both partners benefit equally?

Recognizing and allowing for time constraints

Any successful planning effort in education must consider time. MSP participants agree that time constraints are a hindrance to full participation. This is a theme that appeared in Year One and has continued in Year Two. Participants must work at relieving the problem from both the supply and demand sides. They must acknowledge that to implement any major initiative it must be given priority, and time resources must be reallocated from other competing uses. The problem is particularly acute in the MSP model because major time commitments are intrinsic to the project design. Within this framework, sensitivity to time constraints is necessary in planning the times and venues where individuals might contribute, as well as in affording as much flexibility as possible in how participating K-12 districts and IHEs craft their implementations. How can the project relieve time constraints while remaining faithful to the MSP model?

At the end of Year Two, we find that the Math Science Partnership of Southwest PA has made considerable progress toward achieving its goals. Similar to Year One, the MSP has faithfully adhered to the implementation plan, completing almost all of the planned activities. Moreover, the activities appear to be well-received by the participants, providing teachers and administrators research-based materials and methods to further math and science learning in their districts and schools. Finally, we are beginning to see some expected outputs from many of these activities, such as the production of teacher leaders, changes in attitudes, understanding and awareness of both content and pedagogy, refined courses, and increased interactions among IHEs, IUs, and K-12 schools and districts. In the following years, our evaluation will begin to focus on the outcomes that derive from these outputs. Based on the current progress of the MSP, we are optimistic that many of these targets will be achieved as well.

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Acronyms

Acronym	Definition
AET	Assessment and Evaluation Team
AIU	Allegheny Intermediate Unit
CCSSO	Council of Chief State School Officers
CDA	Comprehensive Data Analysis
CDS	Content Deepening Seminar
IHE	Institution of Higher Education
IU	Intermediate Unit
LAA	Leadership Action Academy
LAT	Leadership Action Team
LoL	Lenses on Learning
MSC	Math Science Collaborative
MSP	Math Science Partnership of Southwest Pennsylvania
NCLB	National Child Left Behind
NCTM	National Council of Teachers of Mathematics
NRC	National Research Council
NSF	National Science Foundation
PDE	Pennsylvania Department of Education
PI	Principal Investigator
PPS	Pittsburgh Public Schools
PSSA	Pennsylvania System of School Assessment
SEC	Surveys of Enacted Curriculum
TF	Teacher Fellow
TIMSS	Trends in International Mathematics and Science Study
TLA	Teacher Leadership Academy

1. Introduction and Background

Overview of the Math and Science Partnership Program

The National Science Foundation's (NSF) Math and Science Partnership program began as part of the No Child Left Behind (NCLB) initiative in 2001, largely in response to growing concerns about the ability of the U.S. to remain competitive in a global economy with continued poor performance of students in math and science achievement. NCLB's education reform agenda included recommendations that the following three issues be addressed: too many teachers teaching out of field; too few students taking advanced coursework; and too few schools offering challenging curriculum and textbooks. One year later, Congress established the Math and Science Partnership program under the NSF Authorization Act of 2002 to focus on these issues.

The Math and Science Partnership is an ambitious program. In the initial program solicitation (*NSF-02-061*), the following goals were identified in an effort to improve student achievement: provide a challenging curriculum for every student; increase and sustain the number, quality, and diversity of teachers of mathematics and science from kindergarten to grade 12 (K-12) through further development of a professional education continuum; contribute to the national capacity to engage in large-scale reform through participation in a network of researchers and practitioners, organized through the Math and Science Partnership program; and engage the learning community in the knowledge base being developed in current and future NSF Centers for Learning and Teaching and Science of Learning Centers.

Although the language has changed slightly in more recent program announcements, the intent for sweeping and sustainable change remains the same. Previous NSF programs targeting math and science educational reform have had similar goals. However, the Math and Science Partnership program is notable in its requirement that higher education be included as a partner, playing a critical role in the K-12 educational reform. Each Math and Science Partnership must include one or more school districts and one or more higher education entities as core partners, with additional partners encouraged, but not required. Moreover, the Math and Science Partnership program expects full participation from mathematicians, scientists and engineers in this effort. In fact, mathematics, science and/or engineering faculty from higher education core partners are required to participate in Math and Science Partnership project activities. It is also clear from previous Math and Science Partnership program announcements that the NSF expects substantial institutional change to occur at both the K-12 and institution of higher education (IHE) levels and plans to study partnership models to learn how partners' commitments result in institutional changes that will lead to the scalability and sustainability of their efforts.

The Math and Science Partnership program supports two types of partnerships, *comprehensive* and *targeted*. The comprehensive projects are funded for a five-year period for up to $7 million annually, depending on the scope of the project. These projects are intended to implement change in mathematics and/or science education in both IHEs and school districts, resulting in improved student achievement across the K-16 continuum. The targeted projects focus on improved K-12 student achievement in a narrower grade range or disciplinary focus in math or science and are funded for up to $2.5 million per year for up to five years. In addition, the Math and Science Partnership program funds research, evaluation, and technical assistance projects that build and enhance large-scale research and evaluation capacity for all Math and Science Partnership awardees and provide them with tools and assistance in the implementation and evaluation of their work.

Although there is considerable flexibility in the individual project designs, all projects are expected to incorporate the following key features:

- *Partnership Driven*. Projects should be designed and implemented by partnerships that unite administrators, teachers, and guidance counselors in participating K-12 core partner organizations; and disciplinary faculty in mathematics, science and engineering, as well as education faculty, in higher education core partner organizations.

- *Teacher Quality, Quantity and Diversity*. Projects should enhance and sustain the number, quality and racial/ethnic diversity of K-12 teachers of mathematics and/or science.

- *Challenging Courses and Curricula*. Projects should ensure that K-12 students are prepared for, have access to, and are encouraged to participate and succeed in challenging mathematics and/or science courses and curricula.

- *Evidence-Based Design and Outcomes*. Project design should be informed by the current literature on learning and teaching, and project outcomes should promise to make evidence-based contributions to the learning and teaching knowledge base.

- *Institutional Change and Sustainability.* To ensure project sustainability, K-16 core partner organizations should redirect resources, and design and implement new policies and practices, to result in well-documented, inclusive and coordinated institutional change at both the college/university and local school district levels.

This program has made 79 awards, including 12 comprehensive projects, 28 targeted projects, and 39 research, evaluation and technical assistance projects. These awards have totaled $419 million to date, which does not include the budgets for future years on ongoing multi-year projects. These awards involve approximately 150 IHEs and 450 K-12 school districts along with a host of other stakeholders.

There is a parallel Math and Science Partnership program at the U.S. Department of Education, also authorized by NCLB. This program requires partnerships to include a state educational agency (or public regional intermediaries such as Pennsylvania's Intermediate Units (IUs), the engineering, math or science department of an institution of higher education, and a high-needs school district. Unlike the NSF program, where funds are awarded in a national competition, the Math and Science Partnership program at the Department of Education awards funds to states to administer.

Overview of Math and Science Partnership Project-Level Evaluation

The Math and Science Partnership program represents a significant investment by the NSF. Accordingly, project-level evaluations are critical to helping the NSF understand and assess the value of its investment. The legislation authorizing the Math and Science Partnership program outlines expectations regarding evaluations of individual projects, explicitly directing applicants to include a description of how the partnership will assess its success. Further specifications for the evaluation can be found in the program announcements, which state that project evaluation should be planned to guide the annual assessment of progress and to measure the impact of the effort. Formative evaluation should provide evidence of the strengths and weakness of the project, informing the partnership's understanding of what works and what does not, in order to inform project evolution and success. Summative evaluation should give an objective analysis of qualitative and quantitative data, in order to determine the effectiveness of the project in contributing to positive student and teacher outcomes and institutional changes.[1] Outside of these broad guidelines, NSF has not provided an explicit framework for project evaluation. Rather, NSF states that the project level evaluation should be specific to the goals of each funded partnership and does not endorse a "one size fits all" evaluation model.[2]

Purpose of this Report

This report is the second in a series of annual evaluation reports that details the evolution of the Math Science Partnership of Southwest Pennsylvania (MSP). The primary purpose of this report is to provide formative assessment of activities to date. In addition, we begin to lay an important foundation for future evaluation reports, by integrating the findings across all data collection activities and by defining baselines for measuring changes in teacher instructional practices, principal practices, and student achievement. Thus, our reporting and analysis of these data will be an important component of our future analyses.

Organization of this Report

Chapter 2 provides an overview of the MSP, describing the partners involved in the MSP, providing some contextual information for understanding the factors that motivated the establishment of the MSP, and describing the organizational and management structure of the MSP. We also provide a logic model of the MSP, which details the three major intervention strategies and the intended outcomes from the MSP activities. The chapter concludes with a description of the overall evaluation design and plan, defining the evaluation research questions, and explaining how we intend to address them. The evaluation research questions discussed in Chapter 2 form the organizing structure for Chapters 3 through 6. The information in these chapters is based on documentation of MSP events, case studies of

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[1] Math and Science Partnership Program Solicitation (NSF03-605), National Science Foundation, Directorate for Education and Human Resources, 2003.

[2] Response to Audit of NSF's Math and Science Partnership Program (OIG Report Number 04-2-003), May 3, 2004.

selected K-12 school districts, surveys of principals and teachers, interviews of IHE faculty and MSP staff, and student achievement and course taking data. Chapter 3 describes the implementation of Year Two MSP intervention activities. Chapter 4 presents findings related to institutional practices and support structures, identified by participants as important to the successful implementation of the MSP project within both IHEs and K-12 school districts. Chapter 5 focuses on the math and science instructional practices of K-12 teachers across the 40 MSP districts, presenting baseline information on the types of classroom practices teachers engage in, the factors that they believe influence their practices, the classroom assessments they use, and the types of classroom activities their students engage in. Chapter 6 describes baseline student achievement data and course taking patterns among the MSP school districts, using statewide data for comparison. Our findings from Chapters 3 through 6 are summarized briefly in Chapter 7, along with several questions arising from these findings for the project to consider as it moves forward. Finally, appendices provide additional details about the instruments and methodology we have used in the course of this evaluation.

2. Overview of the Math Science Partnership of Southwest Pennsylvania

Description of the Partnership

The Math Science Partnership of Southwest Pennsylvania is a partnership of 48 school districts, four institutions of higher education (IHEs), and four partner Intermediate Units (IUs).[3] The NSF award supports 40 of the school districts, and a Math and Science Partnership award from the Pennsylvania Department of Education (PDE) supports the remaining eight. The MSP is headquartered at the Allegheny Intermediate Unit (AIU), the central IU representing also the greatest density of school districts in the region.

Most of the 48 school districts participating in the MSP are within the regions served by the four partner IUs; however, five districts are in neighboring regions served by IUs eligible to become partners during an expansion phase in the fourth and fifth years of the project. The overall region includes the urban fringe of the City of Pittsburgh, several smaller urban areas, suburbs, and rural areas. Total enrollment in the MSP school districts is approximately 114,000 students, with approximately 3,800 teachers who teach math or science topics.[4]

On average, about 39% of students in MSP schools are economically disadvantaged,[5] compared with a statewide average of 36%. This figure is higher in the PDE MSP districts (59%) than in the NSF MSP districts (35%). The enrollment of underrepresented minorities[6] is approximately 19%, compared with a statewide average of 22%. Again, this figure is higher in the PDE MSP districts (25%) than in the NSF MSP districts (18%). These demographics vary widely across schools. The reported percentages for both economically disadvantaged and minority populations vary from 0% to nearly 100% in individual schools.

Similarly, there is a broad range in student achievement levels across the MSP. A substantial portion of MSP schools (17%) are not making adequate yearly progress under NCLB; two MSP districts are identified as “empowerment districts” meaning that they are subject to state control if they do not improve, and one of those districts is already being operated under a state board of control. At the other end of the spectrum, the MSP includes several “blue ribbon” schools, which are among the highest achieving in the state. Chapter 6 contains additional details about student achievement in MSP schools.

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[3] Intermediate Units are publicly funded educational service agencies that act as regional intermediaries between local school districts and the Pennsylvania Department of Education.

[4] Pittsburgh Public Schools (PPS), the largest urban school district in the region, is not formally involved as an MSP participant. Formal inclusion as an MSP partner was not an option at the time of the proposal due to a restructuring of the PPS Board of Education. Nonetheless, district personnel in both mathematics and science have continued their long history of collaboration with the Math Science Collaborative (MSC). [See “Motivation for the MSP of Southwest Pennsylvania” later in this chapter for information about the MSC and its relationship to the MSP.]

[5] We adopt the common practice of using free or reduced-price lunch eligibility as a proxy for economic status.

[6] The racial/ethnic groups included in this category are African-American, Hispanic, Asian, and Native American students.

The four partner IHEs are small- to mid-sized, teaching-oriented, private institutions located in southwest Pennsylvania: Carlow University, Chatham College, Robert Morris University, and Saint Vincent College. Approximately 8,600 students are enrolled in these IHEs, and 46 members of their math, science, engineering and education faculties are participating in this project. Although some of the larger, research-oriented universities in southwest Pennsylvania were invited to participate in the MSP, they declined. In some cases, the university was already involved in educational reform programs. For example, the University of Pittsburgh School of Education was already involved in a Math and Science Partnership through the university's Learning Research and Development Center.

Consistent with the objectives of the overall Math and Science Partnership program, the primary goals of this partnership are to increase K-12 students' knowledge of mathematics and science; increase the quality of the K-16 educator workforce; and create a sustainable coordination of partnerships in the IUs, building intentional feedback loops between K-12 districts and IHEs, tapping the discipline-based expertise of the IHEs, and improving the mathematics and science learning experiences for all undergraduates.

The MSP plans to accomplish these goals through three crosscutting intervention strategies:

- *Professional Development for Leadership* is accomplished through academies and seminars for K-12 educators and IHE faculty. The overriding purpose of these activities is to equip teachers with the pedagogy, content, and leadership skills necessary to become effective leaders in their institutions.

- *Curriculum alignment and pedagogical and course refinement* is accomplished at the K-12 level through the use of curriculum frameworks, and at the IHE level through the contributions of teachers who spend one to two semesters or a summer on the campuses.

- *Support for and dissemination of research based resources and tools* is primarily accomplished through conferences and networks of educators using research-based curricula.

It is important to note that these are not distinct, stand-alone intervention strategies. Rather, they are intertwined in a design that unites K-12 and IHEs in working to achieve the three primary goals of the MSP. Table 2-1 describes the MSP activities that target these three major intervention strategies.

Table 2-1: Primary Activities of the MSP

MSP Activity	Description
Leadership Action Teams and Leadership Action Academies	Leadership Action Teams represent each school district and IHE. Each team assesses strengths and weaknesses in its institution and develops an action plan for improvement. The teams select teachers and administrators to participate in the other MSP activities. District LATs meet collectively four times per year in the Leadership Action Academies, and IHE LATs meet as necessary on their campuses.
Math and Science Curriculum Frameworks	The MSP developed a curriculum framework for science, and refined one for math, with the six to eight big ideas to be taught in these disciplines at each grade level (K-12). The frameworks are intended to help make effective teaching of Pennsylvania's academic standards in science and math manageable, by enabling teachers to focus their time teaching fewer concepts in more depth.
Teacher Leadership Academies	Leadership development for selected teachers, grouped by discipline/level (elementary math, secondary math, and 9^{th}-12^{th} grade science). Trainings will occur over a two-year period, and total 20 days: five days each summer and five days during each school year. The teacher leaders are expected to go back to their school districts and develop "communities of learning," sharing what they learned in the academies with fellow teachers during on-site professional development in their own districts.
Principals' Seminars	Training seminars, entitled *Lenses on Learning*, for district principals to build a deeper understanding of effective mathematics instruction, and develop effective observing and conferencing techniques. These sessions total 38 hours over a one-year period. An additional module has been added to support science education supervision as well.
Teacher Fellows	Support for two teachers from each district over the five-year grant period to spend one or two terms at a partner IHE. During each term, the Teacher Fellow will work with IHE faculty to help refine two IHE courses, take a college course, and assist in MSP activities.
Network Connections	Daylong conference held twice a year, for Leadership Action Teams and other math and science teachers and faculty to explore resources and tools.
Educator Networks	Activities to assist districts in implementing challenging courses and curricula. Groups of teachers from across the region (MSP and non-MSP districts) who are using the same curricula (e.g., Everyday Math, Connected Math, Investigations, etc.) meet to share best practices. State-funded Math Coaches have also formed an Educator Network to support shared learning.
Content Deepening Seminars	Vouchers and stipends to support teachers to attend professional development in math or science content areas sponsored by IHE partners and others, in order to help them become content area resources for peers in their districts.

The first intervention strategy is designed to create cadres of teacher leaders within the partner K-12 school districts and IHEs. Each of the 48 districts and four IHEs has designated a Leadership Action Team (LAT) to enact this strategy. The K-12 LATs nominally include six teachers representing elementary, middle school, and high school math and science, as well as a district-level administrator and a guidance counselor; while the IHE LATs nominally include faculty and department heads representing the math, science and education departments. Each team is charged with the creation of a strategic action plan to strengthen the teaching and learning of math and science in its institution, particularly those courses taken by prospective teachers. An important component of the action plan is the identification of teacher leaders and IHE faculty who will participate in Teacher Leadership Academies that are specialized by discipline and broad grade ranges (K-8 or high school). Participation in professional development by teacher leaders, who then share their experience by replicating the professional development for other teachers in their districts, is expected to build the capacity for change within the MSP partners, by providing training in math and science content as well as pedagogy. Professional development for leadership, however, is not solely limited to teachers. District principals gain a deeper understanding of effective instruction, and develop observing and conferencing techniques that support changes in teacher instructional practices, through Education Development Center, Inc.'s *Lenses on Learning* (LoL) seminar series.

The LATs are also responsible for other aspects of the MSP professional development experiences, such as determining the goals, timing, location, and means of district support for participants. The LATs utilize data specific to their districts in developing these plans, including: math achievement data from the Pennsylvania System of School Assessment (PSSA); science achievement data from the TIMSS (Trends in International Mathematics and Science Study) science assessment administered by this project[7]; results from the project's survey of teacher confidence in math and science content areas; and an analysis of strengths, weaknesses, opportunities and threats that the LATs completed early in the first year. Finally, in order to develop a plan for change in the mathematics and science curricular area, the LATs place their districts on a District Development Matrix, a tool based on the Concerns Based Adoption Model (Loucks-Horsley & Stiegelbauer, 1991). This tool indicates the stage of the district's transition in the adoption and implementation of challenging courses and curricula at the elementary, middle, and high school levels. The work of the LATs is accomplished over four collective meetings, which form the Leadership Action Academy (LAA). Some teams may choose to hold additional meetings in their districts, but this is not an MSP requirement.

The second intervention strategy of curriculum alignment and pedagogical and course refinement is accomplished through the use of math and science curriculum frameworks at the K-12 level. These curriculum frameworks were developed by the MSP and partner organizations in the southwest Pennsylvania region. The curriculum frameworks identify the big ideas that should be taught in each discipline, and at each grade level, in order for students to meet Pennsylvania's academic standards in math and science. A primary goal is to enable teachers to improve on their prior practice by focusing their time teaching fewer concepts in more depth, with less repetition from year to year.

At the IHE level, course revision is primarily accomplished through the MSP Teacher Fellow (TF) program. This program enables two teachers from each district to spend a summer, a semester, or a full academic year at a partner IHE. The teachers are selected by the district's LAT. During each term on campus, it is expected that the teacher fellows will each work with IHE faculty to help refine two IHE courses in which pre-service teachers enroll, take a math or science college course, and assist in MSP activities. The TF program is a critical activity within the MSP as it accomplishes a number of goals. In addition to course revision and refinement, participating teachers receive professional development

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[7] Currently, there is no statewide science exam in Pennsylvania. See "TIMSS Performance of MSP Schools" in Chapter 6 for more information about the TIMSS science exam.

through their enrollment in college courses. Through course revision, IHE faculty become more familiar with state and national content standards while the TFs become more familiar with the depth and scope of specific content. Moreover, the TF also becomes a link between the IHE campus and his/her school or school district, helping to meet the goal of sustainable partnerships.

Finally, the third intervention strategy of disseminating and supporting the use of research-based resources and tools is achieved in part through conferences such as Network Connections that are held twice a year. These meetings also include resource partner fairs where participants can review materials and speak with representatives from various professional development and curriculum providers. Two publications, the *Journal* and *Coordi-net*, are also important elements of the dissemination strategy. They contain a directory of professional development opportunities available in math and science, along with reports of MSP activities, new developments, and lessons learned.

Motivation for the Math Science Partnership of Southwest Pennsylvania

The MSP has its origins in the Math Science Collaborative (MSC), a regional K-12/IHE/business partnership founded in Pittsburgh in 1994. School districts in Pennsylvania are small (with a few exceptions) and independently controlled, and the regional structure of these partnerships provides organizational coherence for multi-district participation while recognizing that not every district will choose to join. The MSC embraced many of the goals that the MSP now has, including a research-based philosophy and organizational principles centered on the use of standards to help guide instruction and promote student achievement. Standards played an important role in the MSC, which originally created district teams to address new national standards in math and science.[8] Later, in 1997, the importance of standards was reinforced with the publication of the results of TIMSS. The findings from the various TIMSS studies were pivotal to the origination of the MSP. These findings demonstrated the importance of standards in setting clear goals and encouraging collegial discussions, and the MSC identified the Math and Science Partnership program as an opportunity to strategically apply what was learned from TIMSS as a continuing focus for change in southwest Pennsylvania.

Many of the current MSP activities, such as Network Connections and the Teacher Leadership Academies, originated in some form within the MSC. The first academies began in 1995, featuring the national standards as well as a resource kit on TIMSS (U.S. Department of Education, 1997). The academies were quite successful, and by 1998 most districts in the region had participated. Since no additional high-quality professional development materials suitable for dissemination were identified at that time, the academies were discontinued. These experiences of the MSC informed the design of the MSP, particularly the importance of leadership, creating district "teams" to plan for change, and of providing adequate release time for teachers to attend professional development.

[8] The *Curriculum and Evaluation Standards for School Mathematics* were produced by the National Council of Teachers of Mathematics (NCTM) in 1989. The *National Science Education Standard*s were produced by the National Research Council (NRC) in 1995.

Many of the current partners were also involved in the MSC, with slightly different roles. For example, each of the IHEs has been involved with the MSC from the start, primarily through participation in meetings that showcased university programs. Similarly, the IUs were also involved in the MSC, taking primary responsibility for professional development. The role of the IUs has shifted in the current MSP model, which includes the IUs as collaborators and full *partners* in change rather than as more loosely associated providers of K-12 professional development and materials.

Pittsburgh Public Schools (PPS) is another example of a longstanding MSC member with an ongoing relationship with the MSP. As explained above, PPS is not a full partner in the MSP; however, PPS personnel have taken part in activities of the MSP that are open to non-MSP districts. In addition, PPS has co-hosted trainings attended by MSP participants.

Organizational Structure and Management of the Partnership

The general organizational structure of the MSP is shown in Figure 2-1. It consists of the MSP Cabinet and the following five project leadership teams: Math Leadership Team, Science Leadership Team, IHE Leadership Team, Assessment and Evaluation Team, and the Budget and Finance Leadership Team. Three of the five project teams have a team leader and a project director. However, on the Assessment and Evaluation Team, the team leader is also co-project director with another team member, and on the Budget and Finance Team there is no separate project director. Team leaders are responsible for guiding the planning of project activities, allocating tasks among team members and developing quarterly team updates on progress and challenges for the Cabinet. Project directors are responsible for the daily follow-up on implementation of specific tasks of the team, ensuring that project targets are accomplished according to schedule, maintaining project documentation, and providing quarterly updates on progress. The K-12, math, and science project directors are full-time employees of the MSP. The IHE project director devotes 75%-time to the project, and evaluation subcontract awards support the co-directors of the Assessment and Evaluation Team, in part. The three faculty members who serve as Math, Science, and IHE team leaders devote 25%-time to the project. Additional members of the math, science, and IHE teams provide their time for team meetings as part of their institutions' commitments to the project.

The MSP Cabinet is the core decision-making body and has the ultimate responsibility for coordination and implementation of the partnership. This includes coordination among partners as well as among the five project leadership teams. The cabinet consists of the principal investigator (PI), the co-PIs, the team leaders, and project directors from the project leadership teams. District representatives are invited to attend cabinet meetings, and several have become monthly participants. Earlier in the project, IU representatives were also on the Cabinet but they later decided to stay up-to-date on the project and share their input via existing IU network meetings. The MSP Cabinet meets monthly.

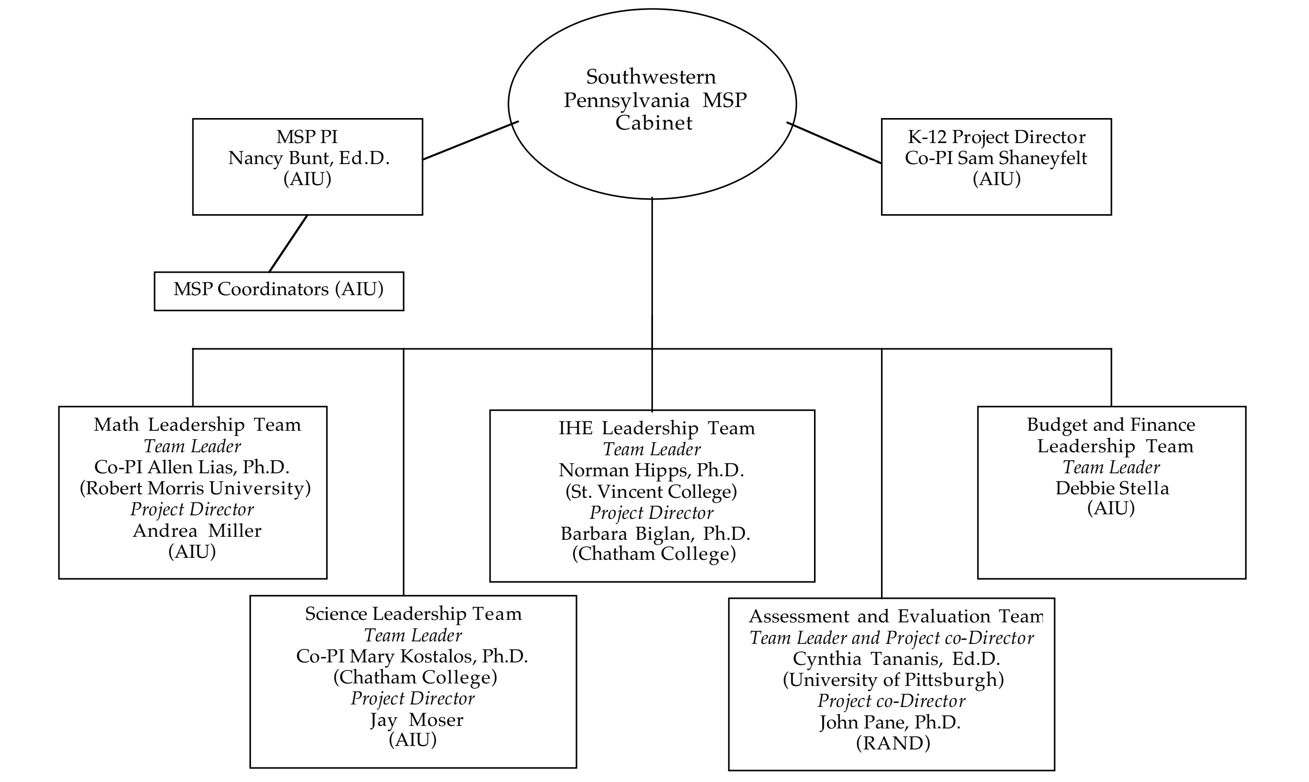

Figure 2-1: Organizational Structure of the MSP

The Math and Science leadership teams are responsible for strengthening teaching and learning in their respective disciplines at the K-12 level. Each of these teams includes an IHE faculty representative as team leader, the MSP PI, additional faculty representatives from the IHEs, MSP Coordinators, and the math or science project director. The IHE Leadership Team is responsible for strengthening practices in teaching and learning of IHE mathematics and science. This team includes the PI and one faculty representative from each of the four IHEs. The Assessment and Evaluation Team (AET) is responsible for documenting student achievement (baseline and progress) and evaluating the project. The team includes the project PI and representatives from RAND, the University of Pittsburgh, and AIU.[9] The Budget and Finance Leadership Team includes fiscal representatives from all partner institutions and subcontractors, and is responsible for all financial matters. Each of these teams meets on a quarterly basis although many have found the need to meet more frequently in order to plan and monitor progress.

The nine MSP Coordinators are a key component of the organizational structure. A group of math and science educators, the MSP Coordinators are responsible for connecting K-12 districts to IHEs and for implementing MSP activities. The MSP Coordinators bring a wealth of experience to the MSP as indicated by their diverse backgrounds, including retired, late career, and early-career K-12 teachers, K-12

[9] In preparation for Year Two, the Assessment and Evaluation Team held a retreat in summer 2004. At that time the team was reorganized as shown in Figure 2-1 to represent the shared work of the two major external partners in the evaluation: The University of Pittsburgh and RAND Corporation. Additional information about the AET is presented later in this chapter.

administrators, and a community college teacher. The MSP Coordinators were hired by the AIU after demonstrating a variety of qualifications including math or science content knowledge, oral communication skills, conflict resolution skills, understanding of project goals, organizational planning skills and motivation. Funding from the MSP grant supports the MSP Coordinators and their work is primarily under the supervision of the MSP PI. During the first year, the MSP Coordinators' contact with the school districts was limited in order for them to develop a common understanding of the project's goals, objectives, and means of accomplishing those goals. Equally important, it prevented district representatives from relying too heavily on the MSP Coordinators, and instead shifted to the responsibility to the LATs in order to develop the confidence and skills they need to act as leaders in their districts, and to interact as peers with teacher leaders in other districts. The expected result was that the MSP Coordinators would be seen appropriately as coordinators, helping districts to build their own capacities, rather than as experts on call to provide capacity to the districts. During Year Two, MSP Coordinator roles shifted to include more active participation with project educators. MSP Coordinators developed and presented the summer and school-year meetings of the TLAs, and have spent a considerable amount of time in the partner IUs in support of project goals.

Theory of Action

In order for the MSP to achieve its goals, a series of sequential steps must occur. In Figure 2-2, we present a logic model that describes how the three primary goals will be achieved. There are many versions of logic models in the evaluation literature, and we are using a simplified version, which includes the traditional components of inputs, interventions, outputs, and outcomes. Below we describe each component of the logic model diagram, moving from left to right.

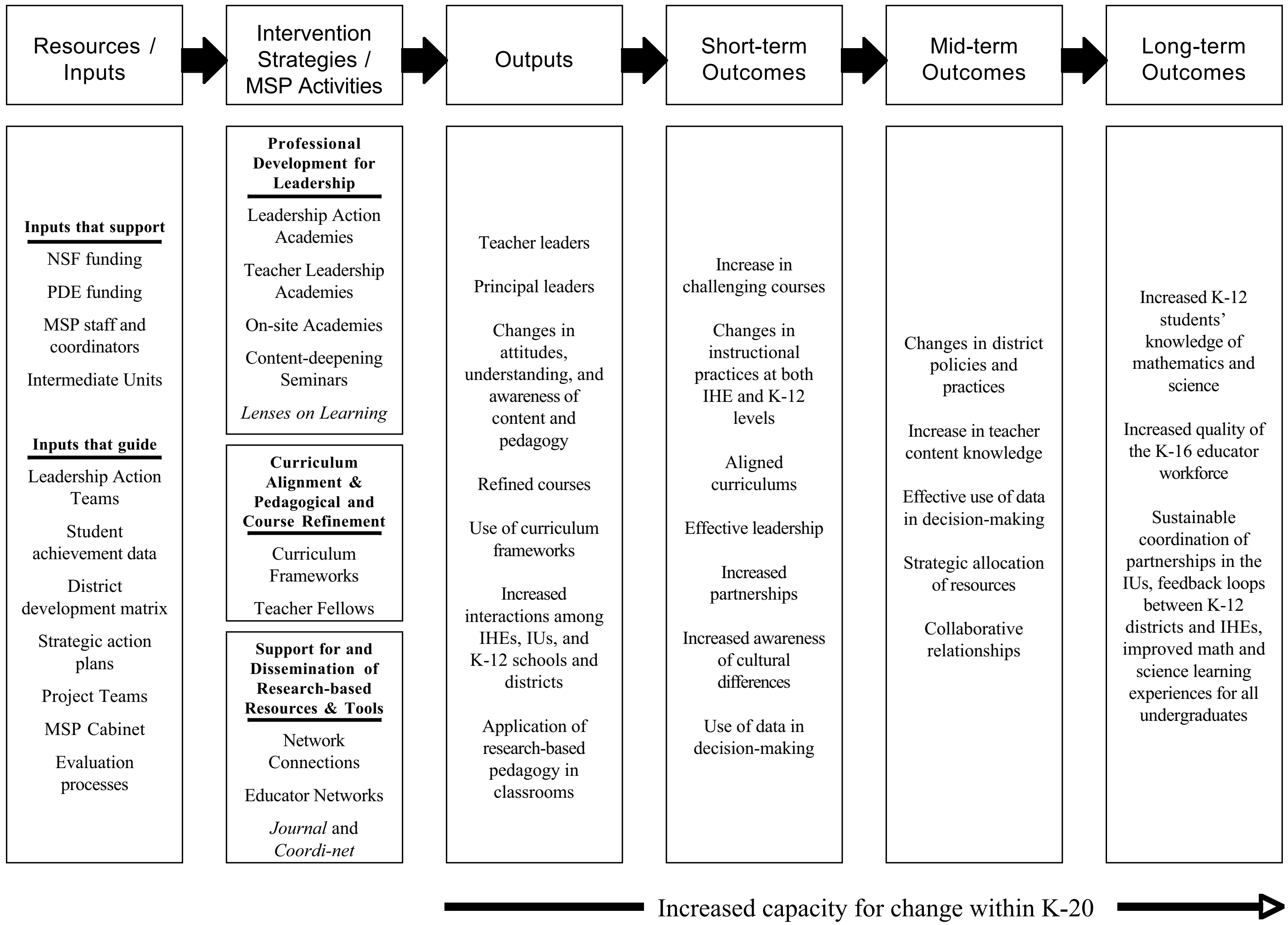

Figure 2-2: Logic Model

Resources / Inputs

The inputs are the resources that support or guide the MSP activities. These include not only funding and human resources, but also the materials and expertise that provide guidance for the MSP activities. The distinction between the different types of inputs is important since a significant amount of MSP resources are expended in developing plans to guide the MSP activities. The NSF and PDE provide the primary funding to support the MSP activities. MSP staff, including the MSP Coordinators, facilitate many of the activities through administrative tasks (e.g., coordinating and maintaining contact with the different partners). As described earlier in the chapter, the LATs are the primary resource for providing guidance to the K-12 school districts and IHEs. Materials and tools such as student achievement data, the district development matrix, and the strategic action plans are all important in helping the LATs to assess and provide the appropriate guidance. The project leadership teams, the MSP cabinet, and feedback from evaluation processes also provide information and guidance that contributes to setting the direction of the MSP activities.

Interventions / MSP Activities

The inputs support the three primary interventions that were described earlier in this chapter. These interventions are based, in part, on research by Deborah Ball on teacher leadership development, Susan Loucks-Horsley on teacher change, and Peter Senge on better communication in learning communities (see, for example: Ball & Cohen, 1999; Loucks-Horsley & Stiegelbauer, 1991; and Senge et al., 2000). The second column of the logic model displays these interventions. Listed below each intervention are the MSP activities that primarily support it.

Outputs

The outputs, in the next column, are the direct and “tangible” products of the interventions. The outputs are aggregated into a single box because in many cases, a particular output is a result of more than one activity. For example, changes in attitudes, understanding, and awareness of content and pedagogy are clearly products of activities listed under the professional development for leadership intervention, but could also be a product of Network Connections or the Educator Networks, both of which are activities that support other interventions.

Outcomes

The next three columns list the expected outcomes that derive from these outputs. In this logic model, outcomes are defined as the products of “outputs + X,” where X is an external factor such as time, or some other factor, such as changes in support structures. Short-term outcomes are therefore items that can be expected to occur as a result of outputs along with additional time. Thus the outputs can be thought of as reasonable precursors to the short-term outcomes. For example, as teachers begin to use the curriculum frameworks, over time we would expect to see that curricula are aligned across the grade levels and with the big ideas outlined by the frameworks. In the case of increased interactions among IHEs, IUs, K-12 schools and districts, a reasonable next step will be increased awareness of cultural differences between and among these institutions. This short-term outcome is a critical precursor to actual change, which might be a mid-term or long-term outcome. Not surprisingly, mid-term outcomes are expected to take longer to achieve, and in some cases may require more than just time. For example, changes in support structures may need to occur before some of the mid-term outcomes can be realized. Finally, the long-term outcomes are the three primary goals of the MSP and should logically follow from the mid-term outcomes.

Evaluation Design and Implementation

The evaluation is designed to monitor progress through this logic model in order to offer formative advice to the project, to measure its ultimate success in achieving its goals, and to document how well the model worked for the benefit of future initiatives that may seek to replicate it. With this in mind, we have identified four evaluation research questions that are not only relevant to the MSP, but are also well aligned with goals and objectives of the national Math and Science Partnership program. The evaluation research questions are:

1. Have MSP partners developed and implemented a comprehensive intervention targeting math and science curriculum and achievement? If so, how?

2. Have institutional practices and support structures changed at K-12 districts and IHEs participating in the MSP? If so , how?

3. Have math and science instruction changed in K-12 districts participating in the MSP? If so, how?

4. In what ways have student outcomes and course taking changed in K-12 schools and districts implementing the MSP? If change occurred, what is the connection between implementation of the MSP plan and these changes?

Question 1 addresses the need to provide formative assessment and documentation of MSP activities, which are important at both the project and program levels. In our annual evaluation reports, we describe things that the MSP is doing well and should continue to do. However, we also try to provide insight into the challenges faced by the MSP and to provide recommendations so that the MSP might make mid-course adjustments. In Question 2, we assess some of the institutional changes at both the district and IHE levels that have taken place as a result of MSP activities. This question is critical to understanding institutional change and sustainability, one of the five key features of the national Math and Science Partnership program. In Question 3, our evaluation examines one of the primary impacts of the MSP, changes in instructional practice at the classroom level. This evaluation question can inform both program and project aims to enhance teacher quality and offer challenging courses and curricula. Finally, Question 4 focuses on the bottom line of student outcomes and changes in course taking practices.

Perhaps one of the most important aspects of our assessment will be analysis to determine whether changes in these outcomes can be linked to the implementation of MSP activities.

To address these research questions, we are using a mix of qualitative and quantitative methods in three distinct but overlapping areas of research and analysis: (1) a formative assessment and documentation of MSP activities, in relation to the institutional goals and student outcomes described above; (2) a qualitative and quantitative investigation of implementation at K-12 districts, including (a) institutional change at the district level, and (b) the links between involvement in partnership activities and curriculum implementation strategies at the district and school level and K-12 student outcomes; and (3) an evaluation of institutional change at IHE partners as a result of involvement in MSP activities.

Data collection activities include observations of MSP events; interviews and/or focus groups of key project personnel and IHE faculty; case studies, including observations and interviews in a sample of MSP school districts that was selected purposively[10]; surveys of K-12 teachers of mathematics and science and principals; pre-post analysis of student achievement data along with statewide comparisons; and pre-post analysis of course completion by K-12 graduates along with regional comparisons. Table 2-2 relates these data collection strategies to the research questions and shows the timetable and sampling methods to be used. The appendices contain additional information about the data collection activities and instruments. Due to space constraints, full copies of the protocols and instruments are not included; however, they are available to project staff and other interested parties on request. The AET is planning to establish an online repository for project staff to access instruments, results, and reports related to the evaluation.

The AET carries out these evaluation activities, with roles divided among teams at RAND and the University of Pittsburgh, as well as an AIU staff member who is the evaluator on the companion PDE MSP project. The AET also includes members of the AIU data group, who are responsible for collecting and managing data on student enrollment, demographics and achievement. In addition to the team's quarterly meetings to report progress and receive input from the project PI, a working group meets at least monthly. A co-director represents the AET at monthly MSP project director and Cabinet meetings.

[10] Districts were selected so that the case studies would sample a broad spectrum of MSP districts in terms of demographics and early implementation measures. Demographic variables included district size, location, economic need, and minority status. Implementation measures included factors such as appointing a full complement of personnel to MSP teams, and the levels of participation in early MSP activities. Seven case study districts were chosen from among the 40 NSF MSP districts and four were chosen from among the eight PDE MSP districts, for a total of 11 districts.

Table 2-2: Evaluation Study Design. This table shows the evaluation strategies, data sources, and sampling methods to be used in the evaluation, and indicates which research questions are informed by those sources.

Evaluation Strategy	Data Source	Research Questions Addressed	Frequency of Data Collection	Kind of Information	Sampling Method
Observations	MSP Events	1, 2	Years 1-4	Qualitative	Representative set of major project activities
Interviews / Focus Groups	Project PI and MSP Coordinators	1, 2	Years 1-4	Qualitative	All
Interviews / Focus Groups	IHE Faculty	1, 2	Years 1-4	Qualitative	Representative sample
Case studies	School districts	1, 2, 3	Years 2-4	Qualitative	Purposive sample of school districts
Survey	Teachers	2, 3	Years 1 & 4	Quantitative	Random sample of teachers
Survey	Principals	2, 3	Years 2 & 4	Quantitative	All principals
Pre-post and statewide comparisons	Student achievement data	4	Years 1-4	Quantitative	K-12 students in tested grades
Pre-post and regional comparisons	Course completion data	4	Years 1-4	Quantitative	K-12 graduates

3. Implementation Strategies and Activities Through Year Two

Question 1 of our evaluation examines implementation. An important goal of the evaluation is to provide formative assessment to assist the MSP in determining whether it is on-track or will need to make mid-course adjustments in order to achieve the intended outcomes. This chapter highlights the activities of the MSP during Year Two,[11] paying particular attention to whether the project is unfolding as planned in the proposal and, where applicable, to discuss areas of change and evolution. A project calendar with specific dates and information about each activity is available via the project website.[12]

Overview of Intervention Strategies

As described in the logic model in Chapter 2, the MSP utilizes three major intervention strategies to achieve its goals of increased student achievement, increased educator quality, and sustainable partnerships. These strategies are professional development for leadership, curriculum alignment and pedagogical and course refinement, and support for and dissemination of research-based resources and tools. Although the logic model is useful in describing the theory of action and the path the MSP plans to take in order to achieve its goals, it does not capture the nuanced and complex interactions among the individual MSP activities. Therefore, in this chapter we provide a detailed account of each of the intervention strategies and the activities that support them. Within each strategy are a variety of planned activities that collectively comprise the overall project implementation plan. This highly detailed implementation plan contains hundreds of action steps across the teams and staff of the MSP. Over the life of the project, we expect the strategies to remain in place, even if the specific activities included within each strategy may change and/or shift in priority. This adaptability, characterized by stakeholders and partners considering and responding to data from the field through team- and Cabinet-level deliberation, is a strength of the project.

As discussed in Chapter 2, the intervention strategies and specific activities are designed to produce change agents that can create and sustain short-, mid- and long-term outcomes. To this end, the activities are intended to produce teacher and principal leaders; changes in attitudes, understanding, and awareness of content and pedagogy among teachers, principals, and IHE faculty; refined courses; use of curricular frameworks, increased interactions among IHEs, IUs, and K-12 schools and districts; and the application of research-based pedagogy in classrooms.

Table 3-1 presents a summary of the main activities of the project as they align with the intervention strategies outlined earlier in the logic model described in Chapter 2. This table further extends the model by indicating primary and secondary strategies and primary and secondary outputs for each activity,

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[11] The project commenced in September 2003, and is currently approximately three-quarters through Year Two. A review of Year One activities and the evaluation materials related to those activities can be found in the Year One evaluation report, as well as the project's full annual progress report for Year One.

[12] http://www.aiu3.net/msc

reflecting the inherent interconnectivity among all of the project's activities. Although the logic model displays activities primarily associated with a single intervention strategy, Table 3-1 illustrates that the project activities are integrated and interactive across the various intervention strategies. In the narrative that follows, each activity is described and summarized within the primary strategy associated with that activity.

The following sections describe the implementation activities during Year Two within each of the three major strategies mentioned above. Each of the major activities within the strategy is described along with a summary of Year Two efforts. The chapter concludes with a discussion of the interactions across strategies and activities.

Professional Development for Leadership

Before change can occur, the capacity for change must be developed. Thus, a major component of the MSP is to build the capacity for sustained change through professional development for leadership, for both teachers and building-level administrators in K-12, as well as through the involvement of IHE faculty in math, science, and education. The MSP model of professional development for leadership includes thorough needs assessment and planning by teacher leaders and administrators, building school-based communities of learners through teacher leadership, and on-site academies designed to disseminate and support pedagogical change more broadly across teachers and schools. IHE faculty offer crucial links to more extensive content knowledge and serve as hosts, advisors, and workshop developers and presenters.

Table 3-1: Alignment of MSP Activities with Intervention Strategies and Outputs

MSP Activity	Intervention Strategies		Outputs	
	Primary	Secondary	Primary	Secondary
Leadership Action Academies (LAAs) and District Leadership Action Teams (LATs)	Professional development for leadership	Support and dissemination of research-based resources and tools	Changes in attitudes, understanding, and awareness of content and pedagogy	Application of research-based pedagogy in classrooms
Teacher Leadership Academies	Professional development for leadership	Curriculum alignment and pedagogical and course refinement	Teacher leaders	Changes in attitudes, understanding, and awareness of content and pedagogy
On-site Academies	Professional development for leadership	Curriculum alignment and pedagogical and course refinement	Changes in attitudes, understanding, and awareness of content and pedagogy	Application of research-based pedagogy in classrooms
Content Deepening Seminars	Professional development for leadership	Curriculum alignment and pedagogical and course refinement	Changes in attitudes, understanding, and awareness of content and pedagogy	Increased interactions among IHEs, IUs, and K-12 schools and districts
Lenses on Learning	Professional development for leadership	Curriculum alignment and pedagogical and course refinement	Principal leaders	Changes in attitudes, understanding, and awareness of content and pedagogy
Math and Science Curriculum Frameworks	Support and dissemination of research-based resources and tools	Curriculum alignment and pedagogical and course refinement	Use of curricular frameworks	Refined courses
Teacher Fellows	Curriculum alignment and pedagogical and course refinement	Professional development for leadership	Refined courses	Increased interactions among IHEs, IUs, and K-12 schools and districts
Network Connections	Support and dissemination of research-based resources and tools	Professional development for leadership	Application of research-based pedagogy in classrooms	Changes in attitudes, understanding, and awareness of content and pedagogy
Educator Networks	Support and dissemination of research-based resources and tools	Curriculum alignment and pedagogical and course refinement	Use of research-based materials in classrooms	Teacher leaders
Journal and Coordi-net	Support and dissemination of research-based resources and tools	------------	Changes in attitudes, understanding, and awareness of content and pedagogy	Application of research-based pedagogy in classrooms

Leadership Action Academy

The Leadership Action Academy (LAA) aims to build in K-12 teachers and administrators the capacity to lead internal district-based professional development. K-12 Leadership Action Teams (LATs) from each district come together to engage in needs assessment and planning for the professional development and implementation activities that will occur within their school districts. Each participating school district designates a team of eight people. The teams nominally consist of an administrator, a guidance counselor, and six teachers, including one math teacher and one science teacher at each of the elementary, middle school, and high school levels. During the second year of the project there were four collective meetings of these LATs, in addition to any meetings convened by individual LATs in their own districts. This is a reduction from the five meetings held in Year One; however, two half-day meetings were combined into a full day meeting in Year Two, so no hours of planning time were lost. These four meetings constitute the LAAs. Two of the LAT meetings consist of the daylong Network Connections conferences discussed later in this chapter, while the remaining two are stand-alone meetings held in the partner IUs.

During Year Two, the LAAs met and included representation from 47 of the 48 MSP districts. While most teams had attendance by the majority of team members, a few districts had fewer LAT members present due to scheduling conflicts or the inability of school and district administrators to be away from their districts for extended periods. IHE partners also have LATs and meet as needed for planning and development purposes. Some meet quarterly, others monthly, depending on the institution's choice.

One of the activities of each K-12 and IHE LAT was to place its institution on a Development Matrix, an instrument based on the Concerns Based Adoption Model (Loucks-Horsley & Stiegelbauer, 1991), to reflect the stage of the institution's transition in the adoption and implementation of challenging courses and curricula. The matrix provides an opportunity for self-assessment related to awareness of the need for reform (insight), beginning steps in reviewing reform options and developing the initial capacity for change (initialize), the early to mid-reform process (implementation), and the deeper systemic accommodation of the reform (institutionalize). Figure 3-1 shows that K-12 districts indicated a positive change across all levels (elementary, middle, and secondary) and content areas (math and science) from Year One to Year Two of the project.

The IHE teams used a similar process with matrices in Year Two as well. As teams began the process, they noted that in a number of cases the initial estimation of baseline placement made early in Year One was inflated. As a result, the IHE teams decided to re-assess the baseline placement made by IHE faculty in Year One. This may have been due to any number of possibilities including the need to respond to a tight deadline for the proposal, the lack of adequate data or expertise to assess capacity at the onset of the project, a lack of understanding of the task or the developmental nature of involvement, or other types of errors. However, involvement in the project may have helped IHE faculty to better assess what they and their institutions do *not* yet possess, as an integral part of the capacity awareness and building process.

Teacher Leadership Academies and On-Site Academies

The teacher leader model employed by the MSP for teacher professional development includes a series of Teacher Leadership Academy (TLA) activities beginning with a weeklong (five day) immersion in the summer, and 5 follow-up sessions throughout the school year. Each academy focuses on content and pedagogy appropriate to specific school levels (elementary, middle and secondary) and content areas (mathematics and science) as well as issues related to teachers' roles as leaders in their home schools. Teacher leaders, who are identified by each district's LAT, attend the TLA and then are expected to implement a set curriculum of on-site academies for teachers in their schools/districts totaling 24 hours annually. Plans are already in place to repeat the same number of days for the TLAs during Year Two. Additionally, the teacher leaders and MSP staff have agreed to decrease the number of days for the third year of the TLAs beginning in 2006, as part of a plan to move toward a self-sustainable model.

During Year Two, TLAs were completed for elementary and secondary math and high school science involving a total of 182 teacher leaders, representing 38 of 40 NSF MSP districts.[13] The higher education partners sponsored the TLAs on their campuses and provided opportunities for involvement by math, science, and education faculty. The partner IUs host school-year follow-up sessions of the TLAs. Participants, as well as the presenters/facilitators, evaluated each academy to enable refinement in subsequent academies. Responses from participating teachers were generally positive. Follow-up sessions enabled teacher leaders to address specific challenges they encountered implementing the on-site academies in their home schools. District case study findings indicate a number of difficulties in implementing the on-site workshops. Although districts nominally had committed to 24 hours of professional development for their teachers via the on-site academies, competing priorities often jeopardized the actual scheduling and content of the professional development. Teacher leaders can be placed in a difficult situation if a supervising administrator usurps the professional development time and/or agenda. Participation and implementation data are being more closely examined to determine the full extent of these issues and to explore potential avenues to address them.

The MSP staff has responded to these challenges by closely monitoring implementation through the MSP Coordinators and by setting up intervention and support strategies, as required. The PI and K-12 project director have met with a number of central office staff and building principals to help resolve scheduling conflicts and misunderstandings of intent and implementation. So too, MSP Coordinators have made good use of collective staff meetings to debrief the evaluation responses received from participants at the summer and follow-up TLAs, reflecting on how to revise the sessions to best support teacher leaders.

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[13] An additional 44 teachers from PDE districts and other districts also attended.

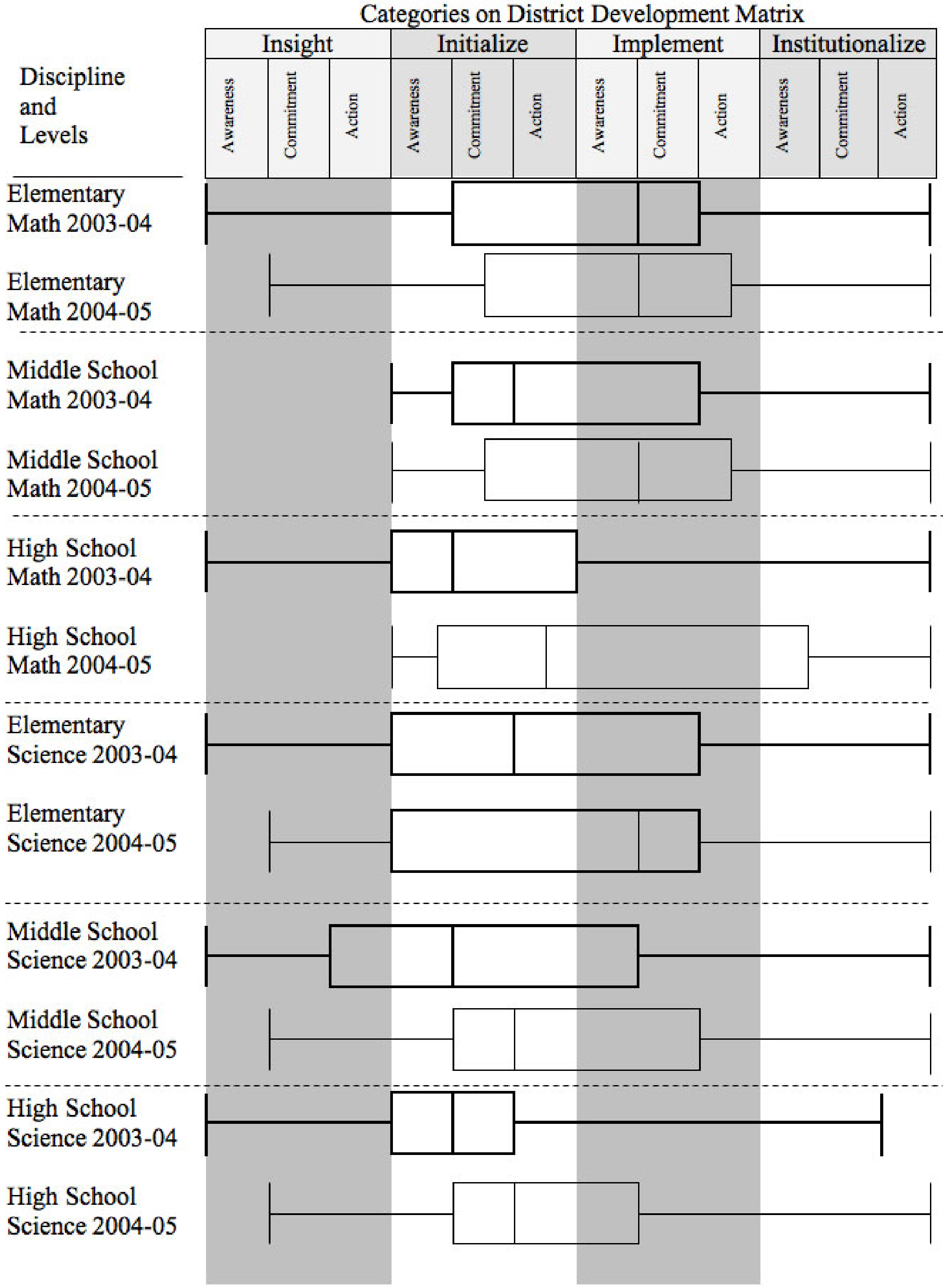

Figure 3-1: Summary of Leadership Action Teams' placement of their districts on the Development Matrix in Fall 2003 and Fall 2004. Each box and whisker plot displays the range of placements across MSP districts: the central vertical line shows the median, the box encompasses the second and third quartiles, and lines show the full range.

The MSP Coordinators and IHE faculty work together to plan and implement the academies, using research based professional development materials that were initially identified in the MSP grant proposal. Both groups attend training sessions led by expert partners, the developers of the professional development materials. The training sessions began in Year One, prior to the implementation of the TLAs and are ongoing in Year Two. Some faculty reported dissatisfaction with the planning process for the TLAs, saying they were asked to *respond to* a pre-determined needs agenda rather than being invited *to help to determine* the needs and agenda and how to fulfill it. This feedback mirrors other comments from IHE faculty, expressing confusion and frustration regarding their roles in the project. These issues may be explained, at least in part, by some of the cultural differences between K-12 and IHE settings. As the project matures, addressing these differences will be crucial for sustainability. Cultural issues are discussed more fully in Chapter 4.

Where appropriate, MSP Coordinators have shared strategies to better assist teacher leaders in resolving conflicts they experience. Yet, despite best efforts of the districts, some have been unable to comply with the planned professional development for teachers. This has been especially true in two of the districts that have been most chronically deficient in participating in ongoing MSP activities, even failing to appoint educators to LATs and to various other roles such as teacher leaders. This lack of early and consistent participation has made sustained levels of implementation more difficult for these districts. The MSP staff has duly noted this, and remedies have been offered, including alternative TLA sessions and a focus on assuring administrator support early in the process.

District case study findings indicate that a number of low-implementation districts are among the most economically and educationally challenged districts in the MSP. These districts are often inundated with reform efforts focused on improving student achievement, yet are often unable to respond to the requirements for reform because of limited staff capacities and other resources. What ensues is a culture of unfocused and unarticulated reform activity that can create counterproductive chaos in an already stressed environment. The added pressure of high-stakes accountability issues (including threatened and actual state takeovers) and public scrutiny by the press and other stakeholder groups can make focused and sustainable reform particularly difficult. Among the case study districts, those that fall into what we would label as the "challenged" category described above, all have reported difficulties in implementing the intended model for reform through the MSP. Early case study data indicate this is often due to competing reform models and interventions in other academic subjects, political conflicts within districts, and a lack of focused "buy in" from key administrators. Additional data from the case studies to be conducted through the beginning of the 2005-06 academic year may provide more conclusive explanations for these difficulties.

Content Deepening Seminars

To augment the efforts of the on-site academies and support content and pedagogical knowledge among teachers, *content deepening* professional development is offered through a variety of resource partners, including the IHE partners in the project. LATs determine the capacity-building needed in their districts and which teachers from their districts can best build these capacities by attending Content Deepening

Seminars (CDSs). The IHE faculty worked to develop the content for these seminars in response to data collected during Year One of the project via a Teacher Confidence Inventory that gathered data on the content areas in which teachers felt more or less confident to teach. The CDSs are designed to provide a menu of opportunities to participating districts to meet the specific needs identified by the district LATs. Vouchers and/or stipends are offered to participants to support their involvement with content deepening experiences. Content deepening professional development offerings were identified and developed in Year Two with most opportunities to be offered during the upcoming summer months. Currently, enrollment for these seminars is moving slowly, with only 178 educators having reserved spots. This represents a low response rate from the well over 700 teachers in participating districts who are eligible to attend these seminars. At the May 2005 cabinet meeting, K-12 representatives reported that administrative issues related to registration and vouchers have made it difficult for teachers to register for the courses. These issues are being addressed for this summer and to make the process more efficient in the future.

In interviews, a number of IHE faculty indicated that they view the CDSs as an important vehicle for establishing and extending their partnership with K-12 teachers, particularly as opposed to the summer TLAs where the focus is more on pedagogy than content. As the CDSs occur through summer months of 2005, each workshop will include a participant evaluation and the results of these will be summarized and debriefed by MSP Coordinators, in order to provide recommendations to the resource providers. A full list of the content deepening offerings is available via the Math Science Collaborative's *Journal*.[14]

Principal Seminars – Lenses on Learning

Central to good supervision are the lenses through which administrators observe classrooms and the ways in which they frame discussions with teachers. When administrators and teachers talk about how children make sense of mathematical ideas, administrators need to bring depth and substance to the conversation; therefore, the administrators' content knowledge about mathematics and ability to recognize math learning are important. Developed by Educational Development Center, Inc., *Lenses on Learning* is a research-based program that prepares administrators to support effective mathematical learning in classrooms. Through viewing math classroom videotapes, analyzing research articles, and engaging in math explorations, participants are led to rethink the observation-conference process focusing emphasis on:

- Student understanding of the mathematical content.
- Teacher understanding of the mathematical content.
- The learning that is happening.
- The teacher's pedagogical practices.

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[14] The *Journal* can be downloaded from the MSC publications website at: http://www.aiu3.net/essdivision/cwp/view.asp?a=2228&q=576488.

- The nature of the classroom intellectual community.
- The teacher's involvement in intellectual community outside of the classroom.

LoL has been offered through sessions held at four partner IUs in the region. Participants in Year Two have included 56 educators from 28 NSF MSP school districts, 15 educators from nine PDE MSP districts, and eight educators from three non-MSP districts in the region.[15] IHE partners have also participated, with five faculty members from three of the partner IHEs attending. Project staff have also developed a follow-up module for science pedagogy, addressing the specific needs of adequate supervision and support of high-quality science education. So far, 23 educators from ten MSP districts have participated in the science training, with an additional four from two non-MSP districts in the region.

Feedback from participants in LoL indicates that this MSP activity has been a particularly meaningful experience. A number of participants report it has been among the best professional development opportunities they have experienced in their careers, and a few have offered testimony of how their practice of supervising and supporting teachers has changed as a result of LoL. Participants report that they are focusing more attention on students when they observe in the classroom, and that the training provided "great" suggestions on supervision, such as the importance of focusing on collaborative inquiry in post-observation conferences with teachers. One participant commented, "The sessions have helped in restructuring the entire interpersonal relationship between supervisor and instructor – raising the level of discourse to focus on the most important aspect of a lesson – the students' learning!" On the principal survey, fully half of principals who participated in LoL reported that it was extremely valuable (five on a five point scale), and a number of write-in comments highlighted the positive influences of LoL. The only other professional development activity rated so highly was "other principal networks,"[16] which were rated as extremely valuable by 63% of respondents who participated in them.

Two sections of the principal survey covered views and influences on mathematics and science instruction. Over the course of the grant, we will monitor changes in principals' responses after they have been exposed to LoL. In the principal survey, we compared responses between the 84 respondents who had participated in LoL and the 58 who had not participated, to determine if there were any differences between these two groups.[17] In general, LoL participants and non-participants responded similarly.

However, a subset of the survey items were examined more closely because the project PI and LoL trainer noted they are well aligned with material presented in LoL. On several of these items, participants and non-participants did respond differentially.[18] LoL participants were likely to place greater importance on

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[15] An additional 48 administrators participated in Year One.

[16] These include the University of Pittsburgh's Principal's Academy and ASSET, a science based network.

[17] Not all of the LoL participants had experienced the entire seminar series at the time of the survey. The respondents included principals who had attended the full LoL series during Year One, as well as principals who were attending the series in Year Two and had only experienced a few sessions. In Year Three we plan to disaggregate the analysis of survey responses by this variable.

[18] In summarizing these differences, we note that it is unknown whether LoL participation is the reason for these differences or if the principals who participated in LoL may have been, as a group, already different from non-participants even prior to LoL. However, if LoL is responsible for these differences in principals' responses, the effect is diluted by the partial participation of some of the respondents, which was mentioned in the previous footnote.

having students work in cooperative groups, having students participate in hands-on activities, and engaging students in inquiry-oriented activities. In addition, LoL participants were more likely to report that observing and conferencing with teachers encourages effective math instruction. In the *Current Practices and Policies* section of the survey, LoL principals reported that they more frequently provide teachers with feedback on effective use of instructional planning time and more frequently work with teachers to develop and share intermittent measures of student learning for all students. Principals were also asked whether professional development is assessed for evidence of improvement in teacher classroom practice, and whether professional development is planned by teachers in the school or district. LoL participants reported that both of these occurred more frequently than reported by their non-LoL colleagues.

It is noteworthy that on the principal survey LoL participants reported less familiarity with their district's mathematics curriculum than non-participating MSP principals, whereas this difference was not present in the parallel question on science curricula. MSP staff and the LoL facilitator hypothesize that one of LoL's initial impacts is for participants to question their own knowledge of mathematics curricula and pedagogy, such that principals may be reporting an increased awareness of *what they do not know*. This may be an important precursor to becoming receptive to curricular and pedagogical reform. Moreover, the MSP Math and Science project directors report that LoL participants tend to recognize the importance of the full schedule and uninterrupted agenda of the on-site school academies, and have advocated for their districts to dedicate the necessary resources to implementing them as intended.

After the inception of the MSP, the Pennsylvania Department of Education made funding available for districts to appoint "math coaches" to mentor colleagues to improve student achievement in mathematics. According to MSP staff, a number of these coaches were less than well prepared for their roles. As a result, the MSP opened the LoL opportunity to math coaches to help them to better understand and support quality mathematics pedagogy. To date, 16 math coaches have received this training, and their evaluations indicate they have highly valued this experience. Additionally, one of the IHE partners has made arrangements for their student teacher supervisors to attend LoL. MSP staff indicate this is an important strategy toward curriculum alignment since student teacher supervisors are often retired teachers who may not be up-to-date with better practices in science and math pedagogy. Education schools voice this concern across the state.

The success of the LoL seminars as a professional development and support strategy has led to it being identified as the required "on-ramp" activity for districts requesting inclusion in the MSP during the planned expansion in Year Three.

Curriculum Alignment and Pedagogical and Course Refinement

The MSP model recognizes that curricular and pedagogical reform and professional development are at the heart of sustainable change in math and science education. The professional development activities detailed earlier include processes to impact pedagogy as well as increase the challenging content in the curriculum as fundamental precursors to student understanding and achievement. In addition to the professional development processes, two activities help to support curriculum alignment and pedagogical and course refinement: the use of curriculum frameworks and the Teacher Fellow program.

Math and Science Curriculum Frameworks

Even before the inception of the MSP project, the Math Science Collaborative, in conjunction with AIU, developed and disseminated the Math Curriculum Framework (Math Framework). The framework aligns the "big ideas" in mathematics with NCTM (National Council of Teachers of Mathematics) standards, the TIMSS (Trends in International Math and Science Study) international benchmarks and standards, and the Pennsylvania Department of Education standards. The framework was developed as a result of a request for advice from local school superintendents regarding coherence and consistency in curriculum across Allegheny County. As a result of the success of the Math Framework as a guide for district-level curriculum development and alignment, the Science Curriculum Framework (Science Framework) was developed two years later as one of the first activities of the MSP project. The project has used these frameworks as an early focus for change in the region, one that was aligned with Pennsylvania Department of Education standards as well as recommendations emerging from TIMSS in 1995 and 1999. The frameworks, coupled with secondary analyses of state achievement test data and consideration of the two TIMSS studies as well as the region's own data as a participating jurisdiction in the TIMSS 1999 Benchmarking Study, provided a basis for both diagnosing curriculum deficiencies and challenges and for beginning to develop a more focused and coherent approach to math and science education for districts across the region.

As the project moved into its second year, the focus shifted from development of the frameworks to their utilization within MSP strategies and activities, such as the TLAs, on-site academies, and *Lenses on Learning*. MSP staff report that the frameworks continue to serve as useful resources and tools for aligning curricula. The Pennsylvania Department of Education recently developed a set of math assessment anchors to help align curriculum, instruction and assessment practices, so the Math Framework was refined this year to include these anchors. Additionally, in the course of creating the Science Framework, the project developed a set of grade level expectations, which are a resource to the PDE as it develops an official set of assessment anchors for science. This is one example of the evolving nature of the MSP project and the expected and planned shifting of emphasis across resources, strategies, and activities as the project matures. This evolution is an important component of long-term sustainability.

Teacher Fellows

The Teacher Fellow (TF) program began in the summer of 2004, allowing teachers the opportunity to engage in one- or two-term resident experiences at one of the partner IHEs. The intent of the TF program is two-fold: to build a bridge for relationships between K-12 and IHE that will benefit both institutions, and to serve as a form of professional development for the TF. TFs refine and revise IHE courses, and also enroll in IHE courses to deepen their own math or science content knowledge. By the end of Year Two, 15 teachers are expected to have participated in this program. This spring, we interviewed all the active TFs (four teachers representing four districts); however, the program is not yet mature enough to see evidence of sustainable relationships, changes in policies (such as student teacher placement), or changes in pedagogy. These are areas to consider in future years.

Among the current TFs, two are spending a full year at the IHEs, and two are spending one semester. Interviews with them, as well as IHE faculty, indicate that the program is generally viewed as successful. Although the TFs reported not having specific expectations for the program before beginning, all reported having developed relationships with faculty. One TF reported taking steps toward building a stronger partnership between the IHE and the TF's school district. The TF has facilitated increased participation by the district with pre-service teachers by hosting student teachers for a visit to the school as part of one of the IHE education methods courses, and facilitating conversations with the school principal regarding placing more student teachers from the IHE at the school. Additionally, one IHE faculty member has invited a TF to return to co-teach a course during a subsequent term. However, at this early stage of the project it is not clear that the TF program will lead to long-lasting relationships between K-12 and IHEs. TFs and faculty did not specify how they planned to continue the relationships after the TFs returned to teaching. In addition, most of the faculty did not report any follow-up contact with the TFs who had completed the program the prior summer. Finally, in one case, a TF will retire after this year, and thus will not return to teaching afterwards.

Regarding course revision by TFs, some faculty questioned the value of mapping state standards to their courses. Getting buy-in from IHE faculty for this idea has been a problem since the inception of the grant due, in part, to the culture of independent course development and teaching in a higher education institution; the IHE team leaders have each tried various means to get faculty on board. In addition, faculty reported that some TFs did not have the disciplinary background to benefit from the college courses. In one case, the IHE team leader recognized that the TF was not able to fully participate in his/her enrolled class, and allowed the TF to drop the class to take an independent study with another faculty member on a topic of interest. This highlights the importance of being able to tailor the experience for each TF.

Support for and Dissemination of Research-Based Resources and Tools

A major strategy of the MSP project involves the use of meetings and publications to build awareness and deepen understanding of research-based resources and tools. The project offers Network Connections semi-annually to bring together teams from across the region to explore resources and share learning; Educator Networks to build communities of practice around the use of research-based curriculum materials in the field, and to support the continued learning of math coaches; and publications to increase awareness of opportunities and resources. Each is described below.

Network Connections

The Network Connections meetings are vehicles for appointed representatives from school districts throughout the 11-county southwest Pennsylvania region to come together with representatives of universities, corporations and non-profit organizations for a full day of connection opportunities. All of the 141 school districts in the region are invited to participate in these semi-annual meetings. District representatives, including teachers, principals, and other administrators such as technology or curriculum coordinators attend sessions relevant to math and science instruction at the K-12 levels. The Math Science Collaborative has held these meetings since 1995. With the addition of the MSP grant, Network Connections meetings became an excellent venue for two of the LAA meetings as well as a forum for disseminating information about the MSP to non-participating districts throughout the region. Morning sessions of Network Connections tend to focus on professional development opportunities or pedagogical reform to support math and science improvement, followed by a plenary keynote speaker. The latter part of the afternoon is scheduled to enable participants to gather together in school district teams to discuss issues of importance such as planning for professional development, as well as for sharing ideas and strategies across districts. These INTERACT (**IN**vitation **T**o **E**ffectively **R**eflect **A**nd **C**ollaborate **T**ime) sessions were established in response to past evaluations that called for joint planning and discussion time during Network Connections.

Network Connections sessions during Year Two were well received by participants. Evaluation findings indicated very high ratings across all sessions and meeting components. A number of participants indicated that gaining exposure to current research findings and other resource information, along with the opportunity to meet as an institutional team, makes Network Connections a valuable resource to participating district teams.

Educator Networks

One of the initiatives of the MSC has been to showcase research-based curriculum materials in math and science. A number of districts in the region are already using or adopting research-based materials such as Everyday Math. The MSP decided to continue support for these research-based materials by forming inter-district user groups, or communities of practice. In addition to Everyday Math, Educator Networks were added during Year Two of the project for Connected Math and Investigations, as well as one for state-funded district math coaches. The Educator Networks are open to all districts in the region regardless of MSP status. This year, 95 educators from 33 MSP districts participated, along with 25 educators from nine non-MSP districts. Feedback and planning data derived from participants indicates the Networks are very effective in providing inter-district discussion of challenges and best practices. The Educator Networks host meetings approximately three to four times a year.

Journal and Coordi-net Publications

Another carryover strategy first used by the MSC and now used similarly by the MSP is a publication tandem, the *Journal* and *Coordi-net*. These sister publications are distributed annually to all math and science teachers in schools throughout the 11-county area. The *Journal* is the larger of the two and offers reports of activity, new developments, and lessons learned in addition to an A to Z resource directory of professional development opportunities available to support math and science education. For example, notices about TLAs, LAAs, Network Connections, and Content Deepening Seminars are provided with details for registration. The *Coordi-net* serves as a mid-year update on professional development opportunities available in the spring and summer, as a supplement to the *Journal*.

Year Two activities included the normal publication and distribution schedule along with reports of increased use of these resources by MSP project schools as a communication vehicle. The MSP has received increased feedback and requests for additional copies of these publications during Year Two. However, even with concerted efforts, including fax back forms and follow up phone calls, distribution of the publications to math and science teachers can be unreliable due to a variety of distribution systems determined and controlled by individual districts. This was further exacerbated by late delivery of the *Journal* into schools this year because of difficulties with the publisher. Some reports from the case study districts are indicative of this difficulty.

Interactions Among Strategies and Sustainability

As discussed earlier in this report and specifically in this chapter, the activities and strategies of the MSP are designed to create a mosaic for concurrent change in a number of areas and populations that will eventually be sustainable. To summarize and discuss them as stand-alone processes does not provide a full account of the synergistic nature of these activities. It may be helpful to examine a "year in the life" of a school district or IHE partner to better understand the nature of these interactions. Our case study methodology will in fact provide closer and more complex "stories" of implementation and impact among K-12 schools as the project and case studies mature.

Through the first two years of the project, K-12 districts and IHE partners have come to better understand the nature of the MSP intervention strategies, and to develop an understanding of the capacities needed to effectively implement the MSP model. So too, each partner has had to address a number of factors that have presented as hindrances to partnership. These include some of the cultural differences between the K-12 and IHE environments, the need to juggle already pressed K-12 schedules and school improvement agendas to accommodate project requirements and expectations, and in the implementation of a professional development model that represents a different conceptual approach than the type of individualized "make and take" workshops many have experienced. IHEs are also being asked to engage in change within their own institutions rather than taking a more traditional role of advising change in K-12 settings. To date, the partners have made good faith efforts to address these and other issues and engage fully in collaborative work. As the project evolves, it is hoped that the complex web of interacting strategies and activities will provide a strong and sustainable foundation for continued reform.

Staffing

A key feature of the MSP design is strategic placement and utilization of staff in support of the project. MSP Coordinators are designed to serve as agents of both the project and the partnering IUs in interacting with K-12 educators and partnering with IHE faculty to develop and present the TLAs and CDSs. Their role has evolved from Year One when they immersed themselves in content and process/pedagogy updates and built relationships from a base at AIU. They now have a more extensive and active role serving districts through the partner IUs. The coordinators are often the "face" of the MSP for K-12 teachers and as such play a crucial role in relationship development and sustainability. As Year Two comes to an end this summer, the project is in the midst of interviewing to fill a number of additional part-time and full-time coordinator positions as well as to replace the departing science project director, who is voluntarily returning to administrative work in one of the MSP districts.

In an equally important and similar role, the IHE project director serves as a key contact and manager of IHE activity. The project originally planned for this to be a half-time position, but extended that to 75%-time in Year Two due to the vital management and planning role this person has played both with MSP staff and IHE faculty representatives and team members. The change has resulted in more face-to-face opportunities for partnership and involvement across the four partner IHEs. Recently, the IHE team leader assisted each IHE partner in examining its level of involvement with the project and its progress toward institutional change using the development matrix discussed earlier in this chapter. This recent activity represents an increased capacity for partnership and engagement as a result of committing more project funding to supporting the IHE team leader position. However, sustaining this level of support will not be possible after the project funding concludes and it will be necessary to find ways to integrate the work of the MSP in IHE settings.

Professional Development as a Process

Although we have discussed the various professional development experiences for teacher leaders, teachers, math coaches, and principals as separate and distinct activities, they work together to influence attitudes, understandings and behaviors of educators. Event and activity summaries and evaluations can indicate whether the program activity has been implemented and if mid-course adjustments were made as a result of feedback and systemic reflection. The MSP has built in a continuous feedback cycle, along with supporting processes within its management system and culture. Data are collected at each discrete event or activity and then debriefed by staff, and occasionally by partners. The debriefing process occurs among staff *across* activities, and among participants *within* a series of professional development sessions such as the TLAs or LoL. This maximizes the potential for information to enter the feedback process, impacting the knowledge of individual staff and participants and also resulting in collective "organizational" learning that feeds the evolution of the project. The internal focus on documentation and the collective reflection on the data with a focus on planning for revision are notable.

As the project evolves, the evaluation plan is designed to detect and report on various indicators of change in curriculum, courses, and pedagogy as a result of project activities, and these changes are ultimately expected to improve student achievement.

Building Administrator Support

The MSP project has recognized from its inception the importance of administrative support in K-12 schools. School principals typically control access to resources, scheduling and priority of professional development and accommodation of new curricula, courses and pedagogy. Further, central office support is essential for any type of sustainable reform. To that end, the MSP has planned for administrative professional development and support through *Lenses on Learning*. As mentioned earlier, this activity is now a required first step for inclusion among the MSP expansion districts in Year Three.

Administrator perception of the effectiveness and impact of the MSP is crucial to continued support. In a survey administered early in Year Two, principals reflected on the relative impact of various MSP activities on math and science instructional practices. One principal was surveyed in each of the 201 MSP schools, and 71% responded. Figure 3-2 summarizes the responses. Among activities rated as having great impact (five on a five point scale), district professional development was cited most frequently, followed by the MSP's Teacher Leadership Academies and *Lenses on Learning*. Among activities having at least some impact (three or higher on a five point scale), district professional development was again cited most frequently, followed by the math and science curriculum frameworks. The MSP activities rated least frequently as having at least some impact were Teacher Fellows, Educator Networks, and Content Deepening Seminars. These perceptions are not surprising because relatively few teachers have served as Teacher Fellows, the Educator Networks have the most direct benefit in the subset of districts that are involved in this activity, and the Content Deepening Seminars will begin in the summer of Year Two. As the focus on various project activities shifts over time, it will be interesting to track administrator perceptions of MSP impact on instruction.

Institutional Context

All of the activities described in this chapter operate within institutions and with people operating in complex contexts. These contexts greatly influence how each activity unfolds and ultimately will determine whether the MSP model can be implemented with fidelity. Chapter 4 considers these institutional context factors in more depth.

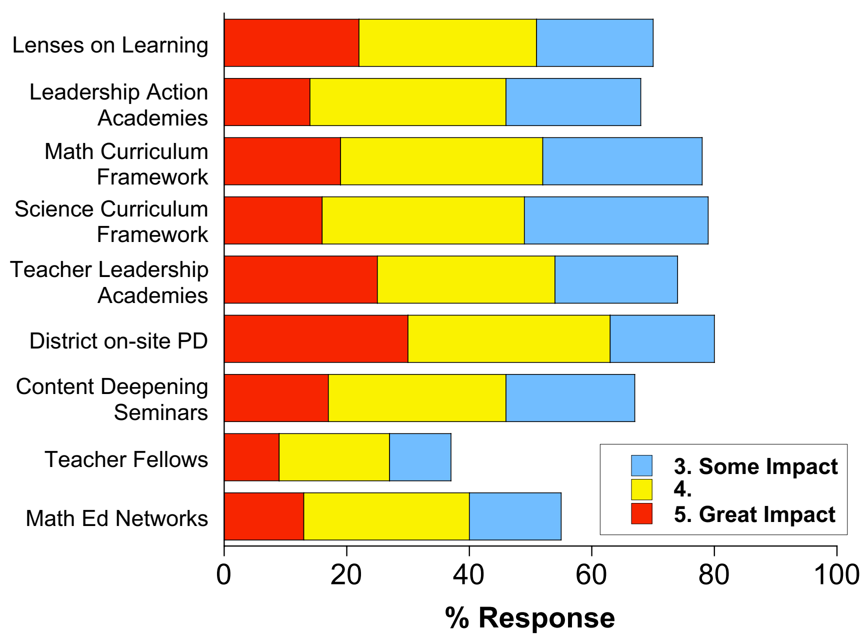

Figure 3-2: Impact of MSP activities on instructional practices, as reported by principals.

4. Institutional Practices and Support Structures

Question 2 of our evaluation focuses on institutional change. In order to achieve and sustain many of the intended outcomes of the MSP interventions, changes in institutional practices and support structures may need to occur. For example, one way to help improve teacher quality is to have teacher leaders mentor pre-service teachers. To achieve this, IHEs and K-12 districts may have to revise policies and procedures to ensure that student teachers are placed in schools that are implementing the practices encouraged by the MSP. This chapter focuses on several institutional factors that are important to successful project implementation and project sustainability. Most of the information discussed in this chapter is based on analysis of qualitative data we collected, including the case studies of K-12 districts and interviews of IHE faculty and teacher fellows. Themes that emerge from this analysis are centered primarily on partnership building and awareness of cultural differences among partners, including differences in incentives and reward structures, work and time constraints, and levels of administrative support.

Partnership Building

A key feature across all MSP projects is partnership development. At the level of the Math and Science Partnership program, NSF places a considerable emphasis on partnership between K-12 districts and IHEs. Additionally, at the project level other partnerships are important, such as those among science, math and education faculty within IHEs; among faculty across IHEs; among IUs; among K-12 districts; and between IUs and K-12 districts. The data suggest that most of these partnerships are evolving. Progress has been made, but changes in institutional structures and practices may be necessary to fully realize the potential of these partnerships.

Partnerships Across and Within IHEs

The IHE leadership team is a key driver of institutional change at IHEs, and is also important for building partnerships across and within institutions. This team, comprised of one representative from each IHE and the project PI, meets monthly to coordinate the MSP work at the IHE level. As such, it is an example of partnership *across* the IHEs. This group makes overall decisions regarding implementation of MSP tasks associated with the IHEs; however, some latitude is given to each IHE to tailor the implementations on its campus, for example in the details of hosting the summer Teacher Leadership Academies and the Teacher Fellows. An example of institutional change facilitated by the leadership team is the work each team has done at the administrative level at their campuses. For consistency across the summer TLAs hosted at each campus, the IHEs had to establish standard fees and credit structures, which was a new experience for them.

There has also been some interaction among faculty across IHEs, particularly among team leaders and project directors, but individual faculty reported in interviews that they would have preferred to have more direct interaction with faculty at other IHEs. They explained two main reasons for this: to improve their professional networks and to exchange ideas about implementing the MSP activities. Because the partner IHEs are generally small- to mid-sized liberal arts colleges with small math and science departments, the faculty view meeting and connecting with colleagues at other IHEs as an opportunity to improve their professional networks. In other cases, the desire for cross-IHE interaction is driven by the need to exchange information and ideas about implementing the MSP. For example, faculty reported they would like to "exchange notes" with their peers at other campuses regarding how to optimize the experiences of Teacher Fellows. To some extent, the IHE partners compete for students within a geographic area or academic program. However, as a result of participating in MSP activities, faculty seem to better understand the goals that are shared across institutions, promoting a focus on partnership rather than competition. In addition, one of the MSP IHEs has deepened its relationship with a neighboring IHE that is not a core MSP partner, by including science faculty from the neighbor IHE as consultants to the project. Faculty at both IHEs noted that, even though the campuses are close to each other, they knew of no other instance where this type of collaboration had taken place between the two institutions. In fact, many of the faculty members had not previously met one another.

To varying degrees, math, science and education faculty reported the development of partnerships among faculty within an IHE, either between math and science faculty, or between education and math or science faculty. However, within an institution, the degrees of partnership varied from strong to virtually non-existent across these groups. In many cases, these partnerships existed prior to the MSP project and continued participation in MSP activities has strengthened these connections. The strongest cases of partnership appear to exist in the IHEs where education faculty are members of the disciplinary department (for example, where math education faculty are members of the math department). In IHE interviews, discipline faculty members reported they are working with education faculty on courses, and in one case, collaborating to publish an article about the MSP.

Partnerships Between IHEs and K-12 Districts

The Teacher Leadership Academies and the Teacher Fellow program provided the first substantial opportunities for partnership building between K-12 school districts and IHEs. These were the first MSP activities in which a large number of IHE faculty directly interacted with K-12 teachers. In both of these activities, some groundwork has been laid for the partnerships.

In interviews, IHE faculty discussed their interest in sharing their expertise with K-12 teachers and the gratification they receive from MSP participation when this happens. Some faculty reported this did not occur with the Teacher Leadership Academies last summer. MSP Coordinators led the TLAs; however, faculty had initially expected to co-facilitate with the coordinators, particularly on parts of the program concerning math or science content. It was during weeklong preparation sessions for staff and IHE faculty, prior to implementing the TLAs, when the faculty roles were made clear. The faculty learned their roles would be to build connections with teacher leaders in order to serve as future resources to them, rather than to facilitate the TLAs. This was a strategic move on the part of MSP staff to ensure that teachers would feel qualified to deliver the material in their district's on-site professional development sessions, and that teachers would not get the impression they must be content experts like the faculty in order to succeed in this endeavor. Faculty also reported that, beyond the TLAs, there has been little follow-up with the K-12 teachers. As a result, some faculty have refocused their efforts on the Content Deepening Seminars, viewing them as a better venue for interacting closely with K-12 teachers.

This model of progressive interaction by IHE faculty, less during the TLAs followed by more during the CDSs, was planned by the project to help promote a common understanding of the MSP model among participants at IHE and K-12 partners. In order to accomplish this, MSP staff report they felt it was necessary to discourage the more traditional role of IHE faculty as "experts" rather than partners. However, this plan may not have been clearly articulated to the faculty, and some report lingering dissatisfaction about the way the TLAs were conducted.

The Teacher Fellow program is one of the primary mechanisms for forging connections between IHE and K-12 school districts. In interviews with the four Teacher Fellows participating during this spring semester, all reported building relationships with faculty during their time on campus, and many of the faculty reported they were excited to be working individually with TFs. As reported in Chapter 3, the TF program has been successful in initiating these partnerships. Over the years, we will assess the degree to which these partnerships are sustained, and whether there are institutional constraints on the roles of TFs when they return to their districts.

The MSP plans to place student teachers in classrooms with teacher leaders, or at least in schools with a teacher leader, for pre-service internships, as a strategy to leverage the impact of the project. This would help build ongoing and direct relationships between the IHEs and K-12 schools, and the changed coursework at the IHEs would have the potential to enhance the resources available to the school through the student teacher. We describe one example of progress in this area in Chapter 3. However, many IHE faculty identified this as a key area where more work can be done. The first cohort of teacher leaders was identified in the summer of 2004 at the TLAs, and the first openings for Teacher Fellows appeared that summer and the following academic year. Faculty at each of the IHEs reported that getting their students placed with MSP teacher leaders is a goal. Now that the teacher leaders have been identified, the faculty at IHEs have made formal requests to districts to facilitate these placements. It is not yet clear how much leverage IHE administrators will have in student teacher placement as a number of external factors influence this process. For example, faculty reported that many pre-service teachers prefer student teaching placements in districts that are close to their homes, where they know that job vacancies are likely to exist in the coming years, or where they know teacher salaries are high. These factors may overrule an IHE desire to place student teachers with teacher leaders in MSP districts.

Partnerships Between K-12 Districts and Between IUs

As a result of participating in MSP activities, teachers from different districts have more opportunities to interact, which has led to increased partnership among the schools and districts. Teachers on LATs not only work with teachers within their districts, but also exchange ideas with teachers and administrators from other districts in LAA sessions that bring together team members who are teachers of math or science teachers at similar grade levels. A similar kind of interaction occurs among LAT administrators. The TLAs, both during the summer and in the follow-up sessions during the school year, bring teacher leaders together from different districts, affording opportunities to share ideas and resources. The follow-up sessions were held at the districts' home IUs, bringing all of the TLA teachers together with teachers from other districts in their IUs. Network Connections also provides opportunities for teachers from various districts to interact, and, finally, the Educator Networks, which are focused on specific curricula such as Everyday Math, bring teachers from different districts together to network and share ideas. These last two examples of K-12 partnership building also include additional districts that are not involved in the MSP. After having experienced these activities, some of the teachers from non-MSP districts are now lobbying for their districts to join the MSP as part of the project's planned expansion in Year Three.

Finally, a partnership is being built among the IUs. The MSP is housed at AIU, but the districts involved in the MSP are from six different IUs. Each full-time MSP Coordinator splits time between AIU and one of the other partner IUs, which are expected to eventually fund the coordinator's salary. This arrangement was agreed upon at the inception of the project and is expected to continue beyond the grant period. This funding from the IUs will begin in Year Four. The partner IUs will have to agree that the coordinator positions are important, and continue this financial support, in order for the project to be sustained for the long term. Additionally, the PI holds regular meetings with the executive directors and curriculum directors within each participating IU to serve as a conduit for information and troubleshooting as well as to address issues such as potential expansion. For similar purposes, the PI and appropriate MSP staff also speak with district superintendents and curriculum coordinators semi-annually during two of their regular monthly meetings at each IU.

Factors that Influence Partnership Development

Awareness of cultural differences among the partners has been an important milestone in Year Two. Many of these differences stem from responsibilities and pressures that vary across institutions. Based on information collected from our interviews, many MSP participants are aware of the cultural issues we describe and are taking steps to address them. Below we describe some that were consistently mentioned in these discussions.

Incentives and Reward Structures

Incentives, rewards, and perceived benefits play a pivotal role in any project that requires individuals to change. District case studies indicate that at the K-12 level the perceived benefits of participation are related directly to teaching, promotion and career advancement. Case study participants also indicate that, given the demand for accountability at the school level in K-12 settings, the potential of improved student outcomes serves as an incentive for participation. Teacher leaders are paid to participate in the TLAs, and can receive college credit or continuing education credit, for their attendance. However, there is some inconsistency across districts on how the teacher leaders are supported. In the case studies, some teacher leaders expressed concern that, while their participation during the summer TLAs is covered with a stipend, all of the extra work they do to prepare for on-site professional development is not.

It is not surprising that the incentives, rewards and perceived benefits of participating in the MSP are different for IHE faculty. IHE team leaders reported that they had used both course reductions and extra salary to compensate faculty for involvement with the MSP, but some stated that the course reduction did not work well. Most of the departments are small, and cannot easily adjust when a faculty member is not teaching a full load. In addition, some IHE leaders reported that faculty seem to respond better to monetary compensation.

Individual faculty members have varied incentives to be involved in the MSP. All of the faculty interviewed were able to describe some of the overall goals of the MSP, and stated they were aligned with their individual goals. They also reported that they hope involvement in the MSP might improve the academic foundation of their incoming undergraduate students. Most faculty acknowledged that their own teaching skills have improved as a result of participating in the TLAs, although they did not state this was a major motivation for them to be involved in the project.

At the *institutional* level, the primary incentives for IHEs appear to be related to financial benefits and improvements in public relations. Faculty reported that being a partner on an NSF grant provides some additional financial support for faculty at the IHEs but just as important is the increased publicity for the IHEs, potentially leading to increased enrollment. In addition, having teacher leaders on campus to participate in the TLAs or as Teacher Fellows increases overall exposure of the IHEs and may attract more adult students as well as traditional students to their campuses. These incentives are considerably different from those of the K-12 school districts, which are primarily focused on improving student outcomes by improving teaching and aligning curricula.

Promotion and Tenure of IHE Faculty

Career advancement for IHE faculty, in the forms of promotion and tenure, is clearly an important factor in the sustainability of the partnership. Tenure considerations play a major role in the ability or willingness of IHE faculty to invest time in MSP activities. The faculty members who are involved in the MSP are split among tenured, tenure track (or probationary), and non-tenure track. Tenure and promotion decisions at the partner IHEs are based on three aspects of the faculty member's performance: scholarship and research, academic and teaching, and service. In interviews, faculty members reported that MSP involvement primarily counts toward the service component of the tenure portfolio, and that service is the least important piece and the easiest to fulfill. Tenure track and probationary faculty reported they feel pressure to develop research portfolios and publish original research articles in peer-reviewed journals, and are uneasy with spending large amounts of time involved with the MSP. One faculty member reported canceling a planned Content Deepening Seminar for the coming summer because of a perceived need to devote additional time to research. Nonetheless, several interviewees noted that many junior faculty are involved in the MSP despite the tenure issue, possibly because they are especially interested in inquiry-based teaching or may recognize the value of the MSP.

In response to these concerns, the IHE team leaders are working to make MSP activities count more broadly in the promotion and tenure decision process. Their arguments are twofold. First, the MSP activities are extensions of, or related to teaching, and should count as academic/teaching activities for tenure decisions. Second, they consider the MSP activities to be research related, and, when coupled with publication in peer-reviewed journals, should therefore be counted as research. However, a number of senior faculty members noted that changing the promotion and tenure policies at IHEs is inevitably a slow process. Addressing these issues is an ongoing need in order to ensure long-term support and involvement by tenure-track faculty. This is especially true since the IHEs involved in this project are striving to bring their level of faculty credentials up to par with more prestigious research-based universities in the region.[19]

One way for the project to help address this is to more actively encourage faculty to publish MSP-related research. Some publications have been written by IHE faculty, in some cases in collaboration with K-12 teachers. In addition, faculty from one IHE reported on MSP activities at a regional conference. These publications are also good examples of partnership building between IHE faculty and K-12 teachers, as well as an incentive for IHE faculty to be involved in the MSP. One publication stemmed from conversations between an IHE faculty and a K-12 teacher during one of the TLAs. The other was a collaborative effort at one IHE, among education faculty, discipline faculty and a Teacher Fellow.

Workload and Time Constraints

Having sufficient time to devote to MSP activities is clearly a challenge for both K-12 and IHE participants. Most IHE interviewees mentioned time as a hindrance to participation. For most faculty members involved in the project, MSP activities are add-ons to their normal teaching, research and administrative workload. At the K-12 level, time has also been a major constraint to implementing MSP activities, the on-site professional development in particular. Additionally, the MSP is dealing with two academic disciplines, only one of which is currently tested by the Pennsylvania Department of Education. Other disciplines and initiatives compete for priority and resources, including professional development time and follow-up, within the K-12 districts. Further, it is not unusual for administrative needs or other pressing current issues to usurp planned professional development time, making planned, focused on-site academies difficult to implement.

Personnel in some case study districts report that the time and work issues have led to some disagreements between participants and MSP staff. The MSP plan calls for 24 hours of professional development per year in each district, to be led by the teacher leaders who attended the TLAs. Districts have tried various tactics to provide this professional development time, but have not been able to implement all of the suggested sessions. In some cases, they have been unable to get the needed substitute teachers; in other cases, their professional development schedules were set before the MSP and LATs began trying to schedule the on-site MSP professional development. Because of some of these issues, personnel in some case study districts perceive the MSP as inflexible regarding the professional development design and unable or unwilling to consider the specific needs or challenges of the districts. At the IHE level, faculty reported incomplete understanding among MSP staff who work full-time for the MSP, and who may not recognize that faculty schedules are not sufficiently flexible for them to attend MSP activities and meetings. At many of the IHEs, department chairs and administrators frown upon the use of "substitute teachers" to cover faculty who would like to attend meetings, and thus many faculty

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[19] This is more than a regional trend. Smaller liberal arts colleges and universities across the country are pressing for higher levels of research and publication efforts by faculty.

are unable to participate fully in planning and other meetings. One idea generated by a faculty member is to pair graduate students in math and science education with discipline-based faculty as teaching assistants. These teaching assistants could then cover for faculty, enabling them to attend more of the planning and training meetings of the MSP.

Finally, some faculty members reported that they are not being included to the extent they would prefer in the process the MSP uses to select interventions and plan events such as the TLAs. This is partly due to the faculty's lack of time to devote to the project. However, even faculty members who have been more involved during the second year of the project report that they are being asked to consent to decisions, rather than being engaged in the decision making process. Some IHE faculty noted that they are accustomed to more debate and open discussion regarding ideas and plans, while MSP staff counter that they must plan and coordinate activities across 48 school districts, four IHEs and numerous other partners, and, although they welcome debate and discussion, there is a limited time and place for that debate.

Administrative Support

Administrative support is important for successful implementation of MSP activities at both the K-12 and IHE levels. At K-12, the case studies of high- and low-implementing districts and interviews with teacher leaders illustrate some of the differences administrative support can make. In districts that appear to be implementing the MSP activities successfully, principals and superintendents tend to show direct support for the activities. For instance, principals from one district have attended the follow-up district-level professional development activities. In addition, the superintendents have attended and introduced some sessions. At one school district, administrators sought and received additional funding to cover the extensive district level professional development, enabling all the teachers, not just math and science teachers, to attend the professional development sessions. However, even in the high-implementing districts there are examples of how structures may need to change to support teacher leaders. In one case, teachers reported that they are unable to implement some of what they learn because their lab periods are too short or because they have to share lab facilities with other teachers. Some of these types of structural and scheduling issues may need to be addressed as the MSP progresses.

In contrast, at K-12 case study districts that are struggling to implement MSP activities, the evaluation team has been unable to even schedule time to interview superintendents in order to begin to understand what the impediments are. In one case, a teacher leader reported that the superintendent is only supportive of the MSP because of the money that it brings to the district, and that at least one of the principals in the district does not even permit teachers to attend Network Connections.

High implementing districts also seem to be flexible in how they implement MSP activities. As mentioned above, one district opened the district level professional development to all teachers, not just math and science teachers. In another instance, a district scheduled only one elementary school to participate in the district level professional development, but after a successful year, it has decided to include all elementary schools in the program. The MSP management has acknowledged the importance of high-level administrative support for the project. During the first year, MSP Coordinators reported, and project leadership confirmed, that districts with strong administrative support were more likely to succeed in implementing MSP activities. In many cases, the tangible evidence of this was principals' participation in the *Lenses on Learning* seminar series. On our survey of principals, *Lenses on Learning* attendees were more likely to report that having students participate in hands on activities, cooperative learning and inquiry-oriented activities is important for effective mathematics instruction. It is too early to determine whether *Lenses on Learning* participants may be influencing teacher instructional practices.

Districts in the case studies have reported other administrative burdens. Collecting all of the data required by the MSP has been burdensome, and tends to fall to one person at the district. Even the task of securing substitute teachers for all of the district level professional development has been problematic in some cases. Principals were asked to rate the roles of their district, IU and MSP Coordinators in supporting or constraining their school's efforts to implement MSP-promoted practices such as data collection and analysis, development of standards, staff development and curriculum. In general, principals reported that all three tend to support their efforts to implement MSP activities, with districts being the most supportive (see Figure 4-1).

On our survey, principals were also asked to indicate their level of agreement on a five point scale to 11 statements about their district's general approach to improving schools. Examples of these statements are:

- The district fosters communication between different schools in the district.
- The district supports my school's efforts to improve.
- The district ensures that student learning is the "bottom line" in the schools.
- The district creates opportunities for educators at the school level to take on new leadership roles.

Approximately 75% of principals reported that they agree or strongly agree with each of the 11 items (range of 65-87%).

In addition, principals were asked ten questions about the kinds of support their districts provide for improving schools, including, for example:

- Developing and maintaining high standards.
- Promoting and nurturing a focus on teaching and learning.
- Using information about student achievement to improve instruction.
- Setting benchmarks and evaluating progress toward them.

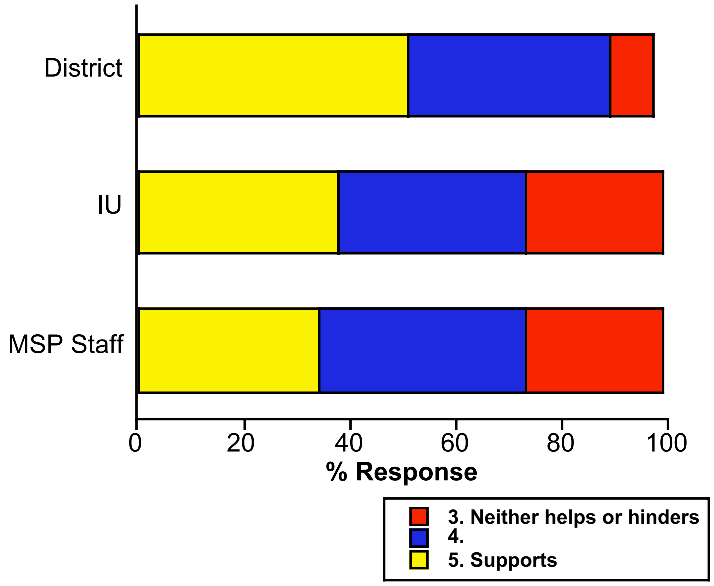

Figure 4-1: Principals were asked to rate, on a five point scale, the overall role of the district, IUs, and MSP coordinators in supporting or constraining their schools efforts in implementing MSP-promoted practices. The majority of principals reported that all three supported their efforts, with the biggest support coming from districts. None of the principals rated any of the three as obstacles (one or two on the five point scale).

Principals indicated the extent to which districts provide each kind of support on a five point scale, with 1 = *not at all*, 3 = *somewhat*, and 5 = *a great deal*. On each of these questions, approximately two-thirds (66.5%) of principals reported a score of four or five. In general, we interpret these results as an indication districts are providing the type of support that might be needed to fully implement the MSP interventions.

As previously discussed, the need for administrative support comes into play at the IHEs regarding the tenure process and student teacher placements. Deans and department chairs play important roles in the tenure process, including setting the criteria for promotion. All four of the IHE Leadership team members hold or have previously held administrative positions such as associate dean or department chair, or have served on rank and tenure committees. As such, they have lobbied with limited success to have MSP activities count for more in the tenure process. Also, in some IHEs, an administrative person handles student teacher placements, and this person must be onboard with the project if they are to facilitate the placement of pre-service teachers with teacher leaders. The project has not articulated a clear model for how to ensure this type of administrative change will occur and be sustained at the IHEs.

Concluding Thoughts

At this early stage in the project, partnership building appears to be one of the most important factors in successfully implementing the MSP and ensuring its sustainability. Many of the institutional and support structures that have been identified as key elements in implementation affect partnership building and the willingness or ability of partners to become and stay engaged. Recognizing and addressing some of the cultural differences between partners will be important to ensure sustainability. Some of the same themes we identify here have surfaced in prior K-12 improvement efforts that have included IHEs as key participants. For example, in *Teachers for a New Era,* an effort to improve the education of pre-service teachers, IHE faculty reported concern about tenure and promotion if they were involved in teacher education reform (Kirby et al., 2004). In that same study, the evaluators noted the importance of engaging IHE administrators to "gain visibility and prestige" for the project, the flexibility given to IHE teams to implement their programs, and the difficulty in getting K-12 teachers involved in a meaningful way, in part because of scheduling problems. Each of these themes has emerged to some extent in the MSP.

5. Math and Science Instructional Practices

Question 3 of our evaluation focuses on changes in instructional practices. Such changes are key to achieving the long-term MSP outcome of improving K-12 student achievement. However, as is commonly reported in the education literature, many factors influence teacher instructional practices. At the end of the first year of the project, we gathered survey data to examine teacher instructional practices and some of the factors that influence them, including preparation, assessments, and activities. The results of the survey were not tabulated in time to be included in the first annual report, so the results are being reported here. The teacher surveys were adapted from the Surveys of Enacted Curriculum (SEC), by the Council of Chief State School Officers, the Wisconsin Center for Education Research, Learning Point Associates, and the TERC Regional Alliance. Although self-report survey data do not always provide a valid measure of classroom practice, responses on the SEC correlate rather well with observations and logs, and this survey is the most practical way to gather such data on a large sample of teachers (Porter, 2002). The survey was administered to 1870 teachers, a random sample of about 55% of the teachers of math and science in the 40 NSF MSP school districts.[20] We received a 66% response rate.

Principals serve an important role in enabling and supporting teacher changes in instructional practices, and our principal survey included a number of items designed to elicit principals' perspectives on this. As mentioned earlier, this survey was administered to 201 principals, one in each MSP school, and 71% responded. Both the teacher and principal survey data reported in this chapter are considered baseline, since the information was collected either prior to or early into the implementation phase of MSP activities.

The MSP expects to influence instructional practices in higher education as well as K-12. Through participation in MSP activities such as the Teacher Leadership Academies, IHE faculty are also exposed to research-based practices. Information from our interviews with higher education faculty suggest that, as a result of participating in the MSP, many are reflecting on their own teaching practices and beginning to implement some of the practices presented at MSP activities.

This chapter highlights the findings from our data on instructional practices. We focus on strategies that are likely to improve achievement of all students, and help close the subgroup achievement gaps (Bennett, A., et al., 2004). This information is crucial in future determination of the impact of the MSP at the classroom level, because it provides an overview of instructional practices that were in use at the start of the MSP. Over the remaining years of the project, we will assess whether MSP activities are influencing instructional practices, and if so, we will note which aspects seem to have been most influenced by the project.

[20] The PDE MSP elected not to participate in this survey.

Classroom Instructional Preparation

One of the major target areas of the MSP is classroom instructional preparation. Many teachers, particularly at the K-8 level, are uncomfortable teaching mathematics and science. Teachers who have not had the disciplinary training in these subjects may be reluctant to use inquiry-based practices that encourage students to think deeply and ask difficult, challenging questions. Thus, improving instructional preparation is a necessary pre-requisite in getting teachers to change their instructional practices.

In our teacher survey, we asked teachers to tell us how well prepared they feel to engage in a number of activities common in mathematics and science classrooms. The response options were: *not well prepared, somewhat prepared, well prepared,* and *very well prepared*. Overall, the majority of teachers consistently reported either being well prepared or very well prepared on each of the survey items listed in Figure 5-1. However, we were particularly interested in the percentage of teachers reporting they are very well prepared because higher confidence levels may be an important first step in presenting challenging curricula to students. In Figure 5-1, we illustrate the percentage of teachers that reported being very well prepared to engage in these practices.[21] This figure highlights a trend we observed across much of the survey data – in each of the classroom preparation items, K-8 teachers of science consistently indicated they are less well prepared than the other subgroups. This could be because teachers at the lower grade levels are often not specialized in teaching only math or science. However, this trend in K-8 teachers of science was not observed in K-8 teachers of math, which also includes non-specialized teachers. More likely, the trend is an outgrowth of historical patterns where relatively more emphasis was placed on math than science in professional development and class time at the elementary level.

The activity for which the largest percentage of K-8 teachers of science indicated being very well prepared is managing a class of students who are using hands on or laboratory activities (44.8%); however, only a quarter (25%) reported feeling very well prepared to take into account students' prior conceptions about natural phenomena when planning their lessons, a critical component in providing instruction that allows students to build on prior understanding. Conversely, high school teachers of math and science appear to be very confident in most aspects of instructional preparation, with over 75% of high school math and science teachers reporting they are very well prepared to teach math or science at the assigned level and over 55% reporting they are very well prepared to provide math or science instruction that meets content standards (district, state, or national). Interestingly, less than one-third (33%) of high school teachers reported they are very well prepared to integrate math or science with other subjects, suggesting that this is one of the few activities for which high school teachers feel less well prepared.

[21] Tables of survey response data, from which the figures in this chapter were generated, are available to MSP staff on request.

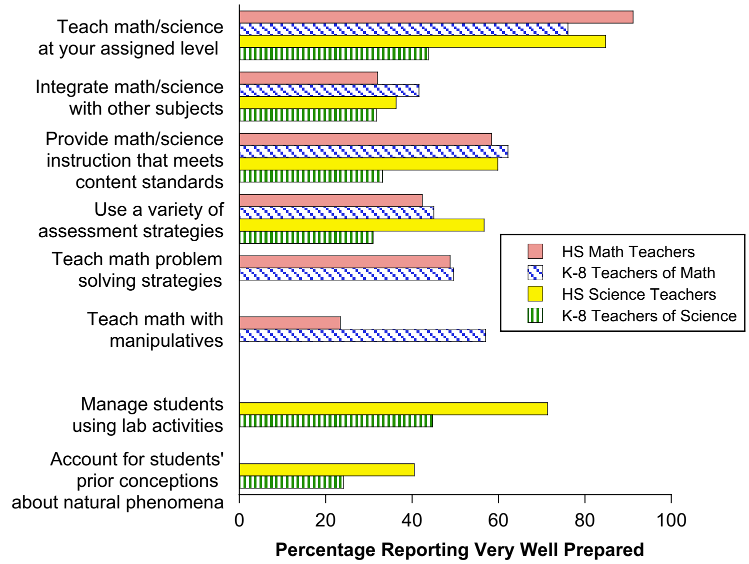

Figure 5-1: Instructional Preparation in Math and Science

Instructional Assessments

The methods used to assess student understanding and the frequency of assessment are critical to developing appropriate strategies for improving student learning. In our teacher survey, we examined how frequently teachers utilize a variety of assessment methods ranging from traditional types such as multiple choice, to methods that are more reform-oriented[22] such as math or science projects. In Figure 5-2, we illustrate the percentages of teachers who reported using various assessments on a weekly basis. Because we are interested in the assessments that are used most frequently, the level of frequency we report is one to three times a week or more. Approximately 45% of high school science teachers, K-8 teachers of math, and K-8 teachers of science indicated that performance tasks, such as hands-on activities, are used on a weekly basis. However, as a subgroup, high school math teachers are clearly outliers, with less than 10% using performance tasks one to three times per week or more. Moreover, 56% of high school math teachers reported using short answer questions on a weekly basis, whereas among the other subgroups this method is used by approximately 45% of K-8 teachers of math, 28% of high school science teachers, and 20% of K-8 teachers of science on a weekly basis. The mathematics surveys included systematic observation of students as an assessment method. More than half of K-8 teachers of math reported using this on a weekly basis, suggesting that, among the assessment methods we included in our survey, this is the most common among this subgroup. Finally, few teachers (less than 5% for high school teachers and less than 10% for K-8 teachers) reported using math or science projects as an assessment method on a weekly basis. However, this is not surprising given that math or science projects

[22] Reform-oriented teaching practices, as encouraged by the MSP, focus on the conceptual understanding of scientific principles and the use of hands-on activities rather than memorization of facts as a means to achieving mathematical or scientific knowledge.

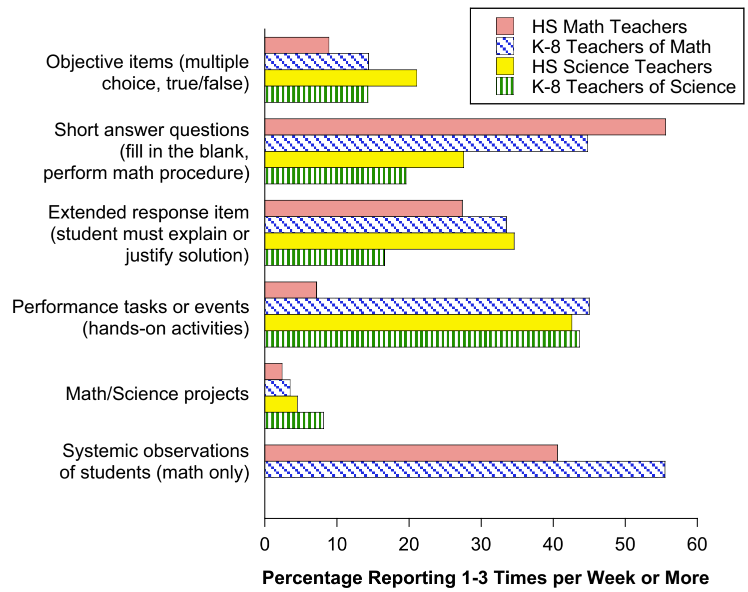

Figure 5-2: Instructional Assessments in Math and Science

may take one month or longer to complete and are probably not appropriate as a frequent assessment tool. The use of project-based assessment is not a focus of the MSP.

In our principal survey, we included questions to determine whether principals feel these assessments are important for effective instruction. The response options ranged from *not important* to *very important*. Similar to teachers, performance-based assessment was rated highly, with 74% of principals indicating this type of assessment is very important for mathematics instruction and 68% of principals rating it as very important for science instruction. Principals also reported that the use of informal questioning to assess student learning is very important, although slightly higher in the case of science, with 62% of principals rating it as very important for science instruction and only 51% giving it this rating for mathematics instruction.

Instructional Influences

Many factors influence teachers' decisions about the content covered and the amount of time spent on various topics in the classroom. External influences such as national standards and state tests are increasingly important to teachers. Results from achievement tests are used as prominent public indicators of a school's quality. Moreover, a school's failure to meet state standards carries a variety of sanctions. NCLB has placed more emphasis on the result of state tests, in many cases causing teachers to adapt their curriculum in order to place more emphasis on topics that are on these tests. The MSP has provided curriculum frameworks in both mathematics and science to assist teachers in determining the big ideas that are critical for high quality learning to occur. However, the curriculum framework is but one of many influences on teacher instructional practices. In our survey, we asked teachers to indicate the degree to which various factors influence what is taught in the classroom. These factors include the state's curriculum framework or content standards, the district curriculum framework or guidelines, textbook/instructional materials, state and district tests or results, national education standards, experience in pre-service preparation, students' special needs, parents/community, and preparation of students for the next grade or level. The response options included *not applicable*, *strong negative influence, somewhat negative influence, little or no influence, somewhat positive influence, and strong positive influence*. Overall, we found that the majority of teachers indicated that each of these factors have a somewhat positive influence or strong positive influence.

In Figure 5-3, we highlight the survey items most relevant to the MSP. The level of frequency reported in this graph is *strong positive influence* since it illustrates some of the differences in the major teacher subgroup trends. Perhaps the most interesting trend to note is that for each survey item listed, K-8 teachers of math had the largest portion reporting strong positive influences. State curriculum frameworks or content standards were reported as a strong positive influence by 66% of K-8 teachers of math, as compared with 50% or less by the other subgroups. Similarly, K-8 teachers of math had the greatest percentage of teachers reporting that district and state tests are strong positive influences. In the case of state tests, the differences between subgroups were fairly substantial, with 42% of K-8 teachers of math reporting a strong positive influence, and less than one-third of each of the other subgroups reporting this influence as strongly positive. On the other hand, the smallest percentage of high school science teachers reported these influences as strongly positive. Not surprising, less than 10% of high school science teachers reported state and district tests as a strong positive influence. This probably reflects in large part, the absence of state tests in science. Similarly, the percentage for the state curriculum framework or content standards was also low, with only 39% of high school science teachers reporting this as a strong positive influence. This trend can be partially explained by the relative emphasis on mathematics in testing, particularly at the K-8 level. Historically, mathematics has received more attention than science in state and district testing programs. The strong positive influence reported by K-8 teachers of math may also be an indication of the degree to which the standards and tests are well-aligned, with teachers not having to compromise in the emphasis they place on topics between the state standards and the state and district tests.

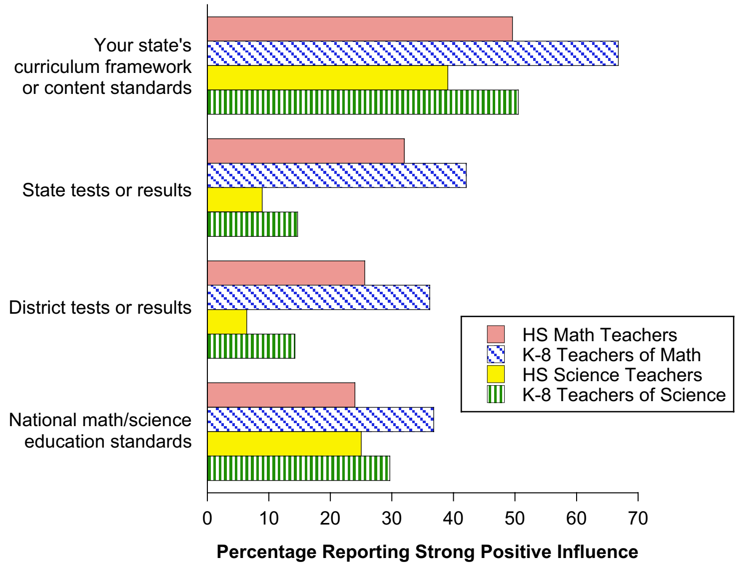

Figure 5-3: Instructional Influences in Math and Science

The principal survey also revealed some notable differences with regards to instructional influences. We asked principals to rate the effect of a number of items including government (federal and state) polices, school policies, instructional materials, and teacher support. Response options ranged from *inhibits effective instruction* to *encourages effective instruction*. With regards to state standards, 63% of the principals reported that this instructional influence encourages effective mathematics instruction, whereas only 39% of principals gave it the same rating for science instruction. Slightly different from teachers, many principals do not find that state testing policies encourage effective instruction, with about one-third (36%) reporting that they encourage effective instruction in mathematics, and even fewer (22%) reporting that they encourage effective instruction in science.[23] The numbers were also low for district testing policies and practices, with only 14% of principals reporting that district testing encourages effective mathematics instruction and 16% reporting the same for science instruction.

Instructional Activities

One of the major emphases of the MSP professional development activities is the use of classroom practices that emphasize hands-on, inquiry-based learning. Through the district on-site professional development, the MSP encourages teachers to challenge their students with more investigative learning. The amount of time that students spend engaged in hands-on inquiry-based practices is, in many cases, an indication of teachers' adoption of these practices and beliefs. In our survey, we asked a number of questions designed to measure how much teachers use practices that are encouraged by the research, for

[23] Even 22% may seem high, since there is currently no state science exam. These principals might view tests as a negative influence on instruction and thus view the absence of a test as a positive influence. Alternatively, the principals may be reporting positive influences on instruction that are already occurring due to the planned phase-in of the PSSA science test in 2008.

example, the amount of emphasis on group work, laboratory investigation in science, problem solving in math, etc. Overall, across all grade levels and subject areas, we found that, even at baseline, prior to participating in MSP workshops and seminars, teachers reported they spend a considerable amount of classroom time engaging in the activities that are promoted and encouraged by the MSP professional development.

At this point, we separate our discussion of instructional activities by subject area, since many of the survey items differed between the mathematics and science surveys. The level of frequency we report is greater than 25% of instructional time for the school year since this was a critical point of differentiation between activities and between K-8 teachers of math and high school math teachers. Overall in mathematics, teachers engaged in activities fostered by the MSP, such as working in pairs or small groups on exercises, problems, investigations, or tasks; or demonstrating solutions to a math problem to the whole class (Figure 5-4). However, there were some significant differences between K-8 teachers of math and high school math teachers. For all of the survey items listed in the figure, the percentage of K-8 teachers of math who spend more than 25% of instructional time engaged in these activities is greater than the percentage of high school teachers. Sixty-five percent of K-8 teachers of math reported spending more than 25% of instructional time using manipulatives (for example, geometric shapes or algebraic tiles), measurement instruments (for example, rulers or protractors), and data collection devices (for example, surveys or probes), whereas less than 10% of high school math teachers spent significant time on this activity.

As part of our examination of teacher instructional activities in math, we were interested in the activities students engage in while working individually and in pairs or small groups. Teachers' responses to these survey questions are summarized in Figures 5-5 and 5-6. When working individually (Figure 5-5), the

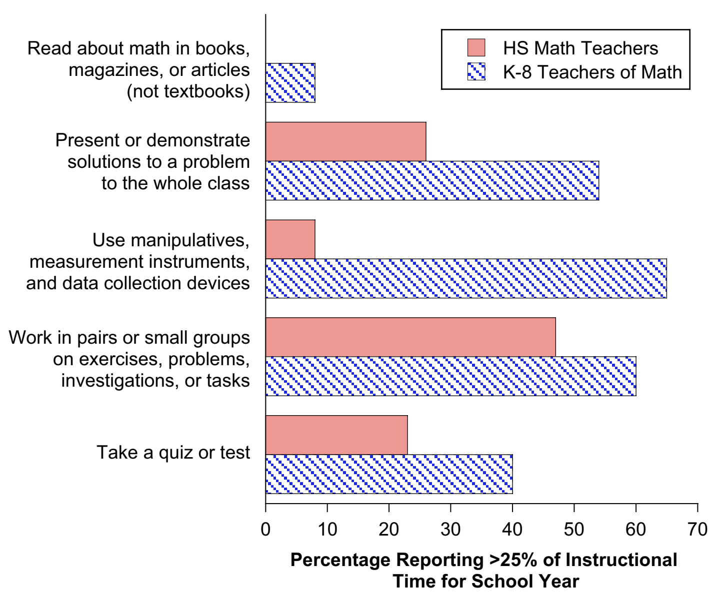

Figure 5-4: Instructional Activities in Math Classes

most often used activity among those we examined at both the K-8 and high school levels is to apply math concepts to "real world" problems. The next most common activities are to explain reasoning in solving a problem; to make estimates, predictions, or hypotheses; to analyze data to make inferences or draw conclusions; and to solve non-routine math problems. Except for solving non-routine math problems, each of these activities is substantially more common at the K-8 level than at the high school level. Finally, among the activities for individuals that we examined, the least common activity at both levels is to complete or conduct proofs or demonstrations of math reasoning.

When students are working in pairs or small groups in math (Figure 5-6), the relative emphasis of each of these activities is similar to when they are working individually. However, unlike the prior question, we do not see striking differences between the K-8 and high school levels on this question. Teachers at both levels reported the most often used activities among those we examined are for students to talk about their reasoning in solving a problem, and to apply math concepts to "real world" problems. The next most common activities are to make estimates, predictions or hypotheses; to analyze data to make inferences or draw conclusions; and to solve non-routine math problems. Similar to when students are working individually, the least common activity when students are working in pairs or small groups is to complete or conduct proofs or demonstrations of math reasoning.

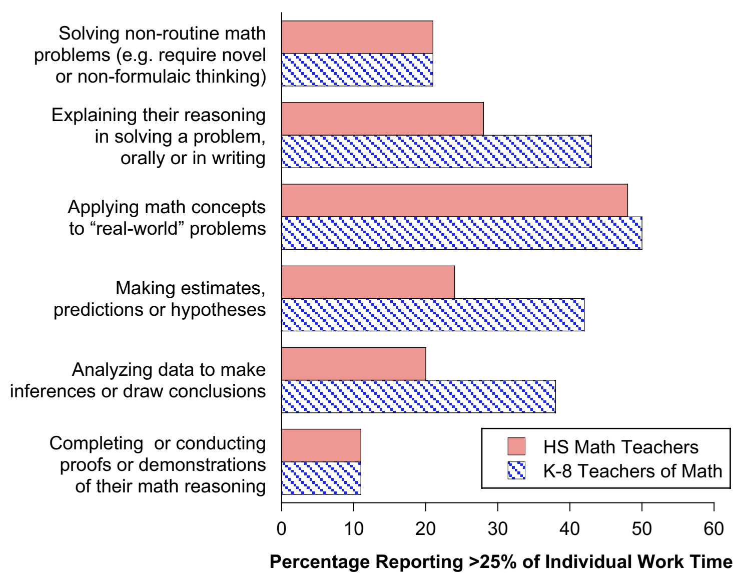

Figure 5-5: Instructional Activities for Individuals in Math Classes

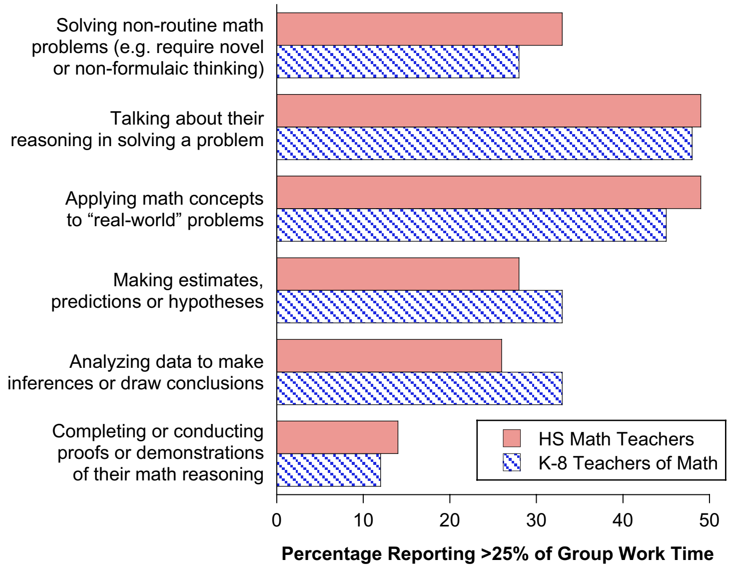

Figure 5-6: Instructional Activities for Groups in Math Classes

With regards to instructional activities in mathematics, overall, we found that principals are supportive of the types of practices encouraged by the MSP, with 70% of principals reporting that having students participate in appropriate hands-on activities is very important for effective instruction in mathematics, and close to half (46%) reporting that having students work in cooperative learning groups is very important. Moreover, principals also claimed to be supportive of the types of classroom environments these practices foster, with 75% indicating that they strongly agree with the statement *I am willing to accept the student conversation and movement that comes with an active classroom*.

In science, we observed some similar patterns in instructional activities as in mathematics. For example, for all of the survey items listed in Figure 5-7, the percentage of K-8 teachers of science who reported spending more than 25% of instruction time engaged in those activities was greater than the percentage of high school teachers. However, the differences in percentages between K-8 teachers and high school science teachers are not as striking as those in math. Whereas reading about math in non-textbooks is a low priority item for both high school and K-8 teachers of math, this activity is emphasized more in science. Approximately 25% of K-8 teachers of science and 10% of high school science teachers reported spending more than 25% of instructional time reading about science in books, magazines, or articles. The difference between math and science in this case may be due to the availability of these materials, with non-textbook science materials being much more plentiful than non-textbook math materials. The MSP encourages less reliance on textbooks if it is to engage students in activity-based learning, as promoted by reform-based pedagogy. Thus, this finding suggests teachers may not be using active learning as much as desired. Less than 10% of the science teachers surveyed reported spending significant time doing a science activity with the class outside the classroom or laboratory, for example participating in field trips, suggesting that in science this is a relatively low priority activity. Not surprisingly, the activity on which

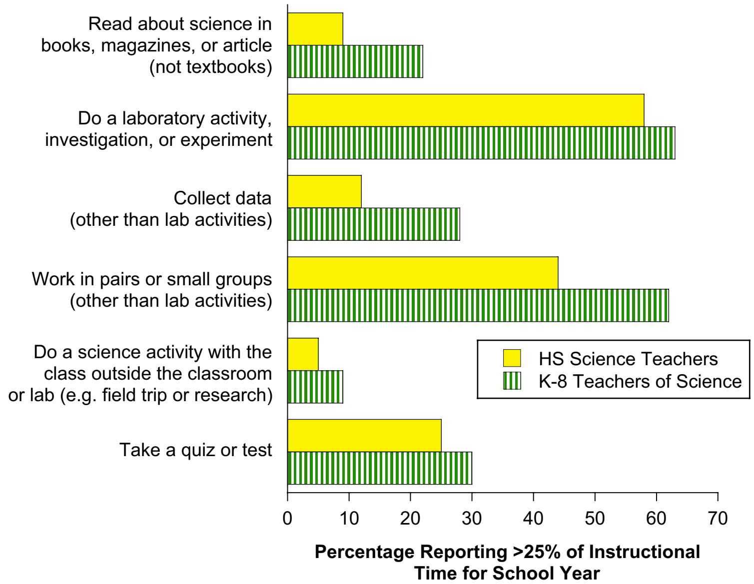

Figure 5-7: Instructional Activities in Science Classes

the largest percentage of high school (59%) and K-8 (64%) teachers of science report spending significant time is laboratory activity, investigation, or experiment.

Laboratory activities and experiments are an important sense-making component of science instruction. Thus, our survey asked teachers about the amount of time during laboratory activities, investigations, or experiments where students are engaged in several specific types of activities. Figure 5-8 shows that the activities most emphasized are making observations/classifications, analyzing and interpreting science data, and organizing and displaying information in tables or graphs. For the first of these activities, K-8 and high school teachers' responses were similar, while for the latter two activities, K-8 science teachers were less likely than high school teachers to report spending significant time on these activities. The least emphasized activity among those we examined is having students design their own investigations or experiments to solve scientific questions, with fewer than 20% of teachers in either group reporting that they utilize this type of activity for more than 25% of lab time.

Finally, we asked teachers how much time students spend working in pairs or small groups outside of laboratory activities. We were particularly interested in two types of pair or small group activities: the amount of time spent talking about ways to solve science problems, and the amount of time spent writing up results or preparing a presentation from a laboratory activity or research project. Both of these activities require students to articulate their thinking and conceptual understanding, and as such might contribute to improving student understanding of scientific concepts (National Research Council, 1996). As shown in Figure 5-9, these activities receive approximately equal emphasis at the high school level, with about 40% of teachers reporting they use these activities for more than 25% of pair/group time. At the K-8 level, more emphasis is placed on talking about ways to solve science problems, such as investigations, with 43% of K-8 teachers indicating emphasis of this activity. In comparison, about 29% of

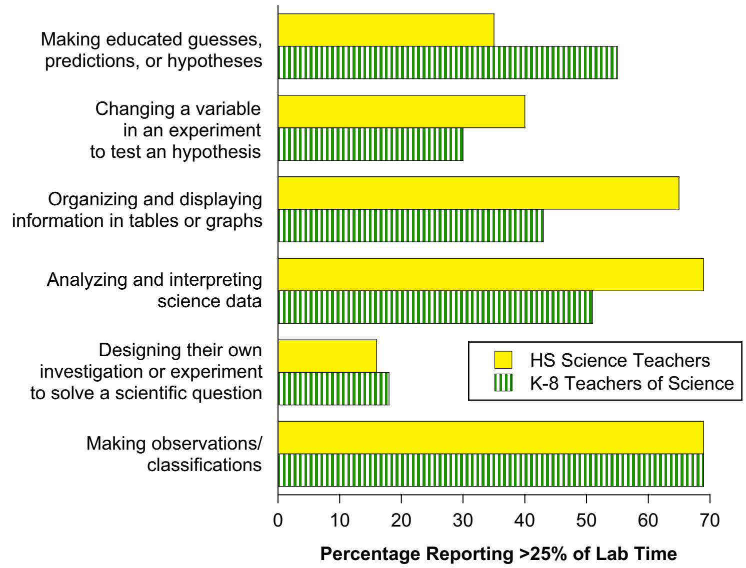

Figure 5-8: Instructional Activities for Science Labs

K-8 teachers indicated emphasis on writing up results or preparing a presentation from a lab activity, investigation, or research project. In sum, when students are working in pairs or small groups in science, a large portion of teachers at both levels reported involving students in activities in which they share their thinking and understanding of scientific concepts.

With regards to instructional activities in science, principals were very supportive of hands-on inquiry-based practices, with over 80% of principals reporting that having students participate in appropriate hands-on activities and engage in inquiry-oriented activities were very important for effective science instruction. Having students work in cooperative learning groups was also viewed as important for effective science instruction, with over 60% of principals rating this activity as very important. Finally, principals indicated a somewhat strong showing of support for the classroom environments these practices foster, with 68% of principals strongly agreeing with the statement *I am willing to accept the student conversation and movement that comes with an active classroom*.

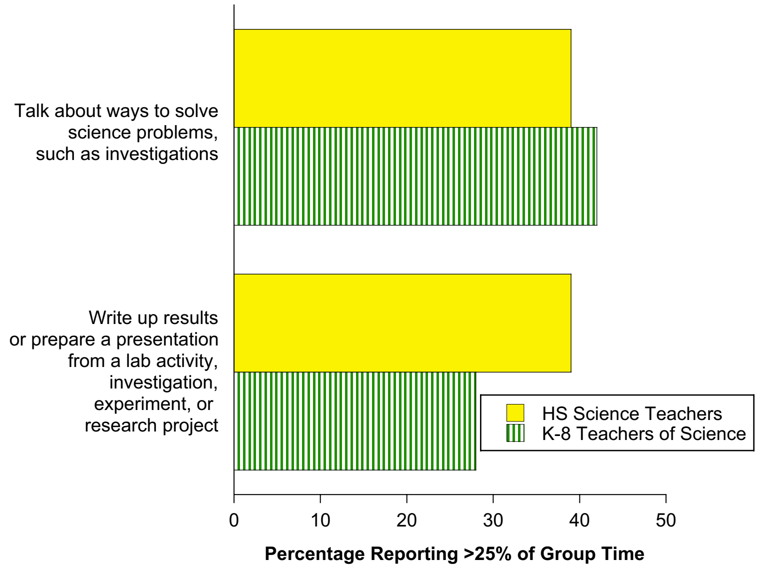

Figure 5-9: Instructional Activities for Groups in Science Classes other than Labs

Instructional Content

The teacher survey included a large section on instructional content. This section asked teachers to report how much time during the school year is spent teaching various math or science topics, and for each of these topics, how much emphasis is placed on various kinds of cognitive demand. The types of cognitive demand include memorization of facts, conducting investigations, communicating understanding, analyzing information, or applying concepts and making connections. This data can be analyzed in a descriptive fashion to study instructional content. For example, the developers of the SEC use contour maps to provide visual displays of this data (Porter, 2002). Such displays enable a general understanding of the focal areas of instruction; overlap, or repetition, from grade to grade; gaps in curriculum coverage across grades; or diffusion of instruction ("a mile wide and an inch deep"); as well as in changes in these attributes over time. However, a descriptive analysis of instructional content was deferred because our primary purpose for collecting these data was to measure the alignment of instruction to reference instruments such as curriculum frameworks, standards, or assessments. Alignment of instruction is one of the short-term outcomes of the logic model presented in Chapter 2. In order to conduct this analysis, the reference instrument must be "coded," a process that creates a parallel data set indicating the topics and emphases of the reference instrument. A panel of content experts usually performs this coding.

One set of reference instruments that could be coded is the MSP math and science curriculum frameworks. The survey data could then be used to measure the alignment of instructional content to these curriculum frameworks at baseline. We plan to re-administer the survey in Year Four of the project, and then the alignment could be re-analyzed to determine if changes in alignment occurred. Alternatively, or in addition, other reference instruments could be coded for this analysis, such as

Pennsylvania's academic standards or assessment anchors, or the PSSA exams. When we selected the SEC survey as the basis for our teacher survey, we were interested in using the curriculum frameworks for this analysis; however, in recent discussions MSP staff have suggested the assessment anchors may be preferred. Since none of these reference instruments are currently coded, the evaluation team is assessing which instrument(s) would be the best ones to code and whether coding one or more of them, and then conducting the alignment analyses, would be a prudent investment of resources.

IHE Instructional Practices

As described in previous chapters, IHE faculty are participating in a number of the MSP activities. Consequently, they are exposed to the same inquiry-based and hands-on teaching practices as K-12 teachers. From our IHE interviews and information collected from the MSP Management Information System,[24] IHE faculty reported that one of the major impacts of the MSP was on their own instructional practices, with some reporting that they have begun to implement many of the ideas seen at the summer academies, as well as at Network Connections.

One of the major ways that the MSP has impacted instructional practices is through increased awareness of the different options for presenting math and science material. Instead of simply presenting material to students through lectures, faculty reported that participation in the MSP made them much more conscious of different teaching strategies than they were prior to participating in the project. A key impact for some faculty members has been the recognition that there are a number of pedagogical techniques that can get students more actively involved and encourage them to construct their own understanding of the content, rather than having the teacher do it for them. Thus, for some faculty, changes in instructional practice have more to do with refining lessons to make them more accessible to the student as opposed to changing the overall content or lesson structure. Faculty members also commented on being more reflective of their teaching practices and more willing to allow students to detect and articulate errors in their own thinking, rather than having them pointed out by the instructor.

In addition to becoming more aware of strategies for presenting content, faculty reported that they have become more aware of the resources and tools available for teaching, such as manipulatives for elementary math courses, or kits for elementary and middle school science courses. Some faculty members reported prior awareness of the value of hands-on instruction, yet that staying current on teaching trends and practices through the MSP has been helpful when teaching pre-service teachers.

Concluding Thoughts

This chapter has described our baseline findings on instructional practices, focusing mainly on strategies promoted by the MSP. Here we briefly summarize the findings. Overall, across all grade levels and subject areas, we found that even prior to participating in MSP workshops and seminars, teachers

[24] http://www.msp-mis.org/

reported they spend a considerable amount of classroom time engaging in the activities that are promoted and encouraged by the MSP professional development, and principals are generally supportive of these practices. For a number of classroom preparation items, K-8 teachers of science consistently indicated they are less well prepared than other subgroups of teachers. High school teachers of math and science appear to be very confident in most aspects of instructional preparation, such as teaching math or science at the assigned level and providing math or science instruction that meets content standards. As a subgroup, high school math teachers are less likely than the other subgroups to report they use performance tasks, such as hands-on activities, to assess student progress on a weekly basis. Conversely, high school math teachers are more likely than other teachers to report using short answer questions weekly. K-8 teachers of math had the greatest percentage of teachers reporting that district and state tests are strong positive influences on instruction. However, many principals reported they do not find state testing policies encourage effective instruction. In the next chapter we turn our attention to student achievement and course taking in order to get a baseline from which to measure change over the course of the MSP.

6. Student Outcomes and Course-Taking

The bottom line for the MSP is to be able to demonstrate improved student learning in mathematics and science. This is reflected in the goals of the partnership, one of which is to increase K-12 students' knowledge of mathematics and science through an increase in the breadth and depth of their participation in challenging courses and curricula. Question 4 of our evaluation seeks to measure changes in student outcomes and course taking over the course of the project and determine to what extent these changes can be attributed to the MSP interventions. We plan to do this by collecting student achievement data, teacher-student links, and data on teacher participation in the project. These data will be used in a statistical model to test whether participation in MSP activities can be linked to student achievement gains.

In this chapter we discuss some of the student outcome measures that we plan to use to assess changes in student achievement. We also provide data on student achievement in the MSP school districts prior to the implementation of MSP intervention strategies, as a baseline reference point, and compare MSP districts with statewide achievement data in order to gain a better understanding of their similarities and differences relative to other school districts in the state of Pennsylvania.

Student Outcome Measures

One of the most important student outcome measures is the Pennsylvania System of School Assessment (PSSA), a standards-based, criterion-referenced assessment used to measure students' attainment of the Pennsylvania academic standards. Historically, the PSSA has been administered to students in grades 5, 8, and 11 in reading and mathematics. A writing test was added in 2002 in grades 6, 9, and 11, and more recently reading and mathematics tests have begun to be administered in grade 3. By 2006, the PSSA will cover grades 3 through 8 and grade 11, in reading and mathematics. A science PSSA is scheduled for 2008, to be administered in grades 4, 8, and 11.

Four performance level descriptors are used for the PSSA: the *advanced* level reflects superior academic performance, *proficient* reflects satisfactory academic performance, *basic* reflects marginal academic performance, and *below basic* reflects inadequate academic performance. These performance levels are not available in the first year of operation of an exam. Therefore, as of 2003-4, performance levels are available only for grades 5, 8, and 11 in reading and math, and grade 11 in writing.

The PDE reports school-level PSSA results statewide, and in this chapter we are using school-level results to describe the student achievement of MSP schools relative to the rest of the state's schools in the analyses of mathematics achievement below. Because no PSSA science exam is currently implemented, the MSP project is administering an alternative science test. This test is provided by the PROM/SE[25] Math and Science Partnership at Michigan State University, and is based on TIMSS. Because this science

[25] Promoting Rigorous Outcomes in Mathematics and Science Education, http://promse.mspnet.org/.

test is not administered statewide, there are no comparison data available for use in describing the MSP schools.[26]

PSSA Mathematics Performance of MSP Schools

Achievement in MSP schools relative to statewide averages

In order to describe the baseline performance of MSP schools, it is first useful to compare the schools to statewide averages. Table 6-1 shows the percentage of students scoring *advanced* or *proficient* on the PSSA mathematics exam in 2003-4. Columns display the percentages statewide, in the NSF MSP districts, and in the PDE MSP districts.

This table shows that the NSF MSP schools generally outperform statewide averages, and the PDE MSP schools generally under-perform the statewide averages. However, this simple comparison does not take into account the student populations served. For example, schools serving relatively disadvantaged student populations might excel at educating their students, yet compared to other schools in the state that include relatively advantaged student populations their performance might appear to be quite low.

Achievement in MSP schools relative to schools with similar student populations

To conduct a more meaningful analysis we created a statistical model that predicts student achievement based on a set of school-level demographic variables that are known to correlate with student achievement. In essence, this analysis allows us to compare each MSP school with peer schools in Pennsylvania that serve similar populations. The demographic variables in the model include socio-economic status, race/ethnicity, limited English proficiency, and geographic locale (urban, rural, etc.). This model produces a very good fit to the student achievement data across Pennsylvania schools, confirming that the demographic variables are highly correlated with achievement.

We focus on the difference between a school's actual performance and its performance as predicted by the model. Where the difference is positive, the school is performing better than predicted by the

Table 6-1: Math Achievement of MSP Schools Compared to Statewide Averages. NSF and PDE MSP schools are compared to statewide averages on percent of students scoring proficient or advanced on the PSSA mathematics exam in 2003-4.

	Statewide Average	NSF MSP Schools	PDE MSP Schools
Grade 5	62%	68%	60%
Grade 8	58%	58%	35%
Grade 11	49%	52%	32%

[26] We are currently exploring possible benchmarking processes for these TIMSS data with Michigan State University and the PROM/SE MSP. As soon as we receive guidance, our project will conduct and report a benchmark analysis.

demographics of its student population; and where the difference is negative, the school is not performing as well as predicted. Table 6-2 shows the average over- or under-performance of NSF and PDE MSP schools, in terms of percent *advanced* or *proficient*. For example, on average, NSF MSP high schools have 3.5% more of their students performing at advanced or proficient levels than would be predicted by the demographics of their student population. These differences are statistically significant, suggesting that at baseline, there is strong evidence the NSF MSP schools are somewhat better than average after controlling for the demographics of their student populations. For PDE MSP schools, the results are mixed: elementary schools perform better than predicted while middle schools and high schools under-perform.

The range of PSSA math achievement across MSP schools serving 5th grade students is displayed graphically in Figure 6-1. Each symbol on the chart represents an individual school. The placement of each school's symbol is determined as follows: x is the model's prediction for the percentage of students in the school scoring *advanced* or *proficient*; and y is the actual percentage of students in the school scoring *advanced* or *proficient*. The diagonal line, where $x=y$, is where actual achievement is equal to predicted achievement. Thus, schools that are plotted above the diagonal line are performing better than the model predicts, and schools below the line are performing worse than the model predicts. The figure uses solid symbols to plot the schools for which the difference from prediction is statistically significant, and hollow symbols for the schools for which performance is not significantly different from the model prediction. In addition, NSF and PDE MSP school districts use distinct symbols, and crosses are plotted over the symbols of schools that are in case study school districts.

The figure displays several interesting characteristics of MSP schools. First, the horizontal spread of schools on the graph shows that MSP schools represent a broad range of student demographics. Schools at the left side of the graph have student populations that typically do not perform very well on the PSSA, while schools at the right side of the graph have student populations that typically perform quite well. Second, focusing on the solid symbols in the graph, it can be seen that MSP schools represent a mix of schools; some that under-perform their peers and thus appear below the line, and some that over-perform their peers and thus appear above the line. Finally, focusing on the symbols with crosses, it can be seen that our purposive sample of case study districts has generally captured the range of variance on both of these dimensions. The case study schools are spread from the left side of the graph to the right

Table 6-2: Achievement of MSP Schools Relative to Model of Statewide Achievement. The model includes several demographic characteristics of the student population that co-vary with student achievement. The table reports the percentage of students who score proficient or advanced on the PSSA in excess of predictions from this model. Positive numbers indicate that more students than predicted achieve at the advanced or proficient levels, and negative numbers indicate that fewer students than predicted achieve at the advanced or proficient levels.

	NSF MSP Schools	PDE MSP Schools
Grade 5	2.8%	3.0%
Grade 8	2.0%	-6.7%
Grade 11	3.5%	-2.8%

side, and some fall significantly below the line, some near the line, and some significantly above the line. Figures 6-2 and 6-3 tell similar stories for the PSSA math performance of schools serving 8^{th} and 11^{th} grade students, respectively.

In sum, this model of school achievement will enable us to more carefully monitor achievement in MSP schools and help us more effectively assess changes in achievement over the course of the project. We will be able to factor into our evaluation how well schools were performing prior to the start of the project, not just in absolute terms but also relative to schools serving similar student populations. As an example of the benefits of this model, consider a scenario where external factors cause a general rise in student achievement statewide over the course of the project. A simple analysis may be unable to rule out a hypothesis that the same external factors caused all of the increases observed in the achievement of MSP schools. However, if the amount by which MSP schools outperform the model increases (upward movement in Figures 6-1, 6-2 or 6-3), an argument can be made that these increases are related to participation in the MSP (or to some other characteristic that MSP schools might share). As mentioned in the opening paragraph of this chapter, we are also working towards a more detailed model that includes individual-level student achievement and demographics data, teacher-student links, and data on individual teachers' participation in the project. This model is expected to enable even more sensitive tests of the link between MSP participation and gains in student achievement.

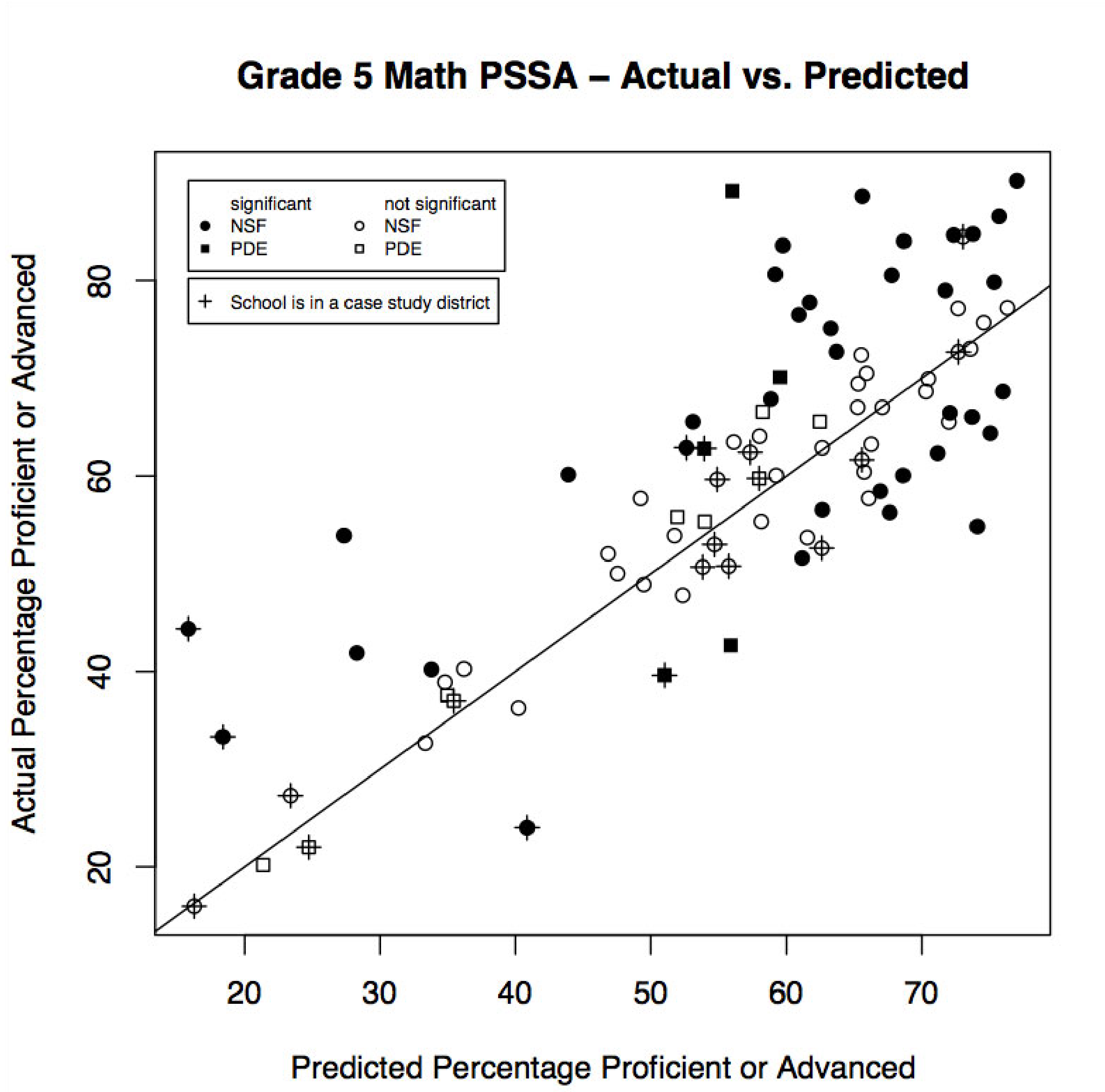

Figure 6-1: 5th Grade PSSA Mathematics Performance of MSP Schools. Schools are plotted relative to scores predicted by a statistical model fit to statewide data and using demographic covariates of achievement. Hollow symbols represent schools where the difference from predicted is not statistically significant, while solid symbols represent schools where the difference is significant. Circles represent NSF MSP schools, and squares represent PDE MSP schools. A cross symbol is overlaid on the circle or square if the school is within one of the school districts in our case studies.

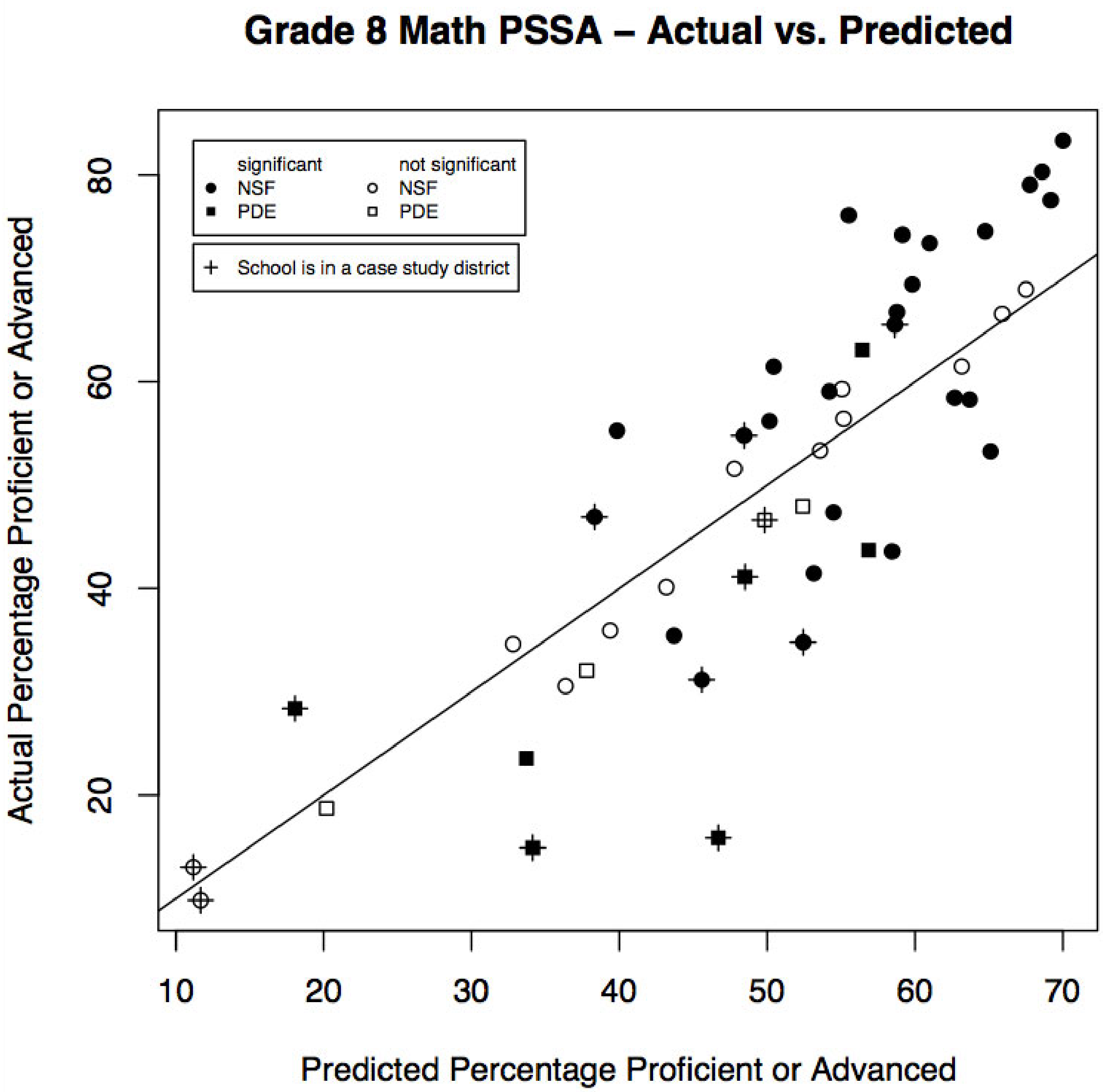

Figure 6-2: 8th Grade PSSA Mathematics Performance of MSP Schools. Schools are plotted relative to scores predicted by a statistical model fit to statewide data and using demographic covariates of achievement. Hollow symbols represent schools where the difference from predicted is not statistically significant, while solid symbols represent schools where the difference is significant. Circles represent NSF MSP schools, and squares represent PDE MSP schools. A cross symbol is overlaid on the circle or square if the school is within one of the school districts in our case studies.

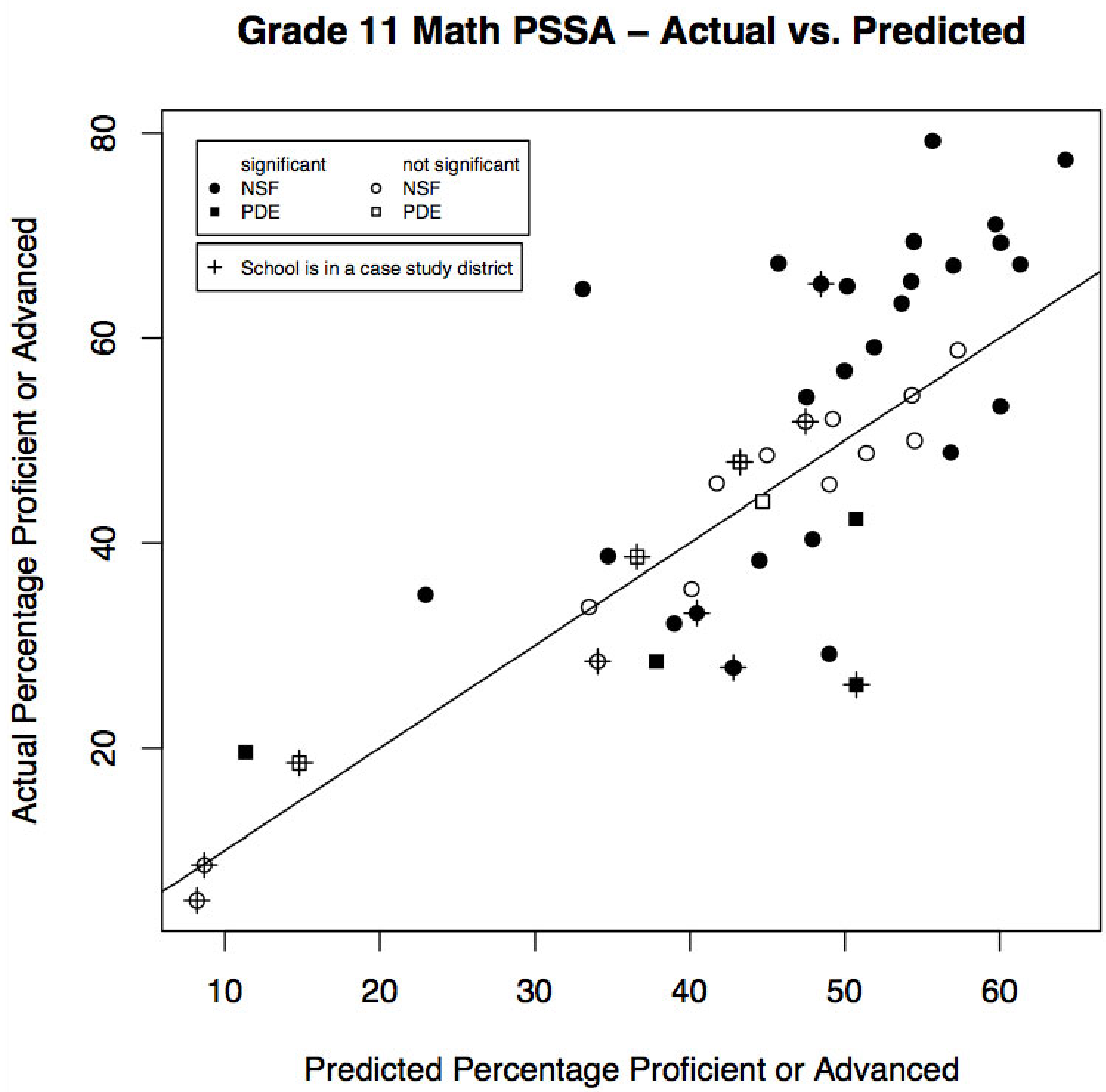

Figure 6-3: 11th Grade PSSA Mathematics Performance of MSP Schools. Schools are plotted relative to scores predicted by a statistical model fit to statewide data and using demographic covariates of achievement. Hollow symbols represent schools where the difference from predicted is not statistically significant, while solid symbols represent schools where the difference is significant. Circles represent NSF MSP schools, and squares represent PDE MSP schools. A cross symbol is overlaid on the circle or square if the school is within one of the school districts in our case studies.

TIMSS Performance of MSP Schools

The Pennsylvania Department of Education has postponed the PSSA science test until 2008. Thus, in order to evaluate student achievement in science, the MSP is administering a TIMSS science test annually, through the cooperation and support of PROM/SE. All MSP districts are administering this science test, and some are administering a math test that is also available. As an additional site administering these exams, we hope to be able to compare our results with PROM/SE and other jurisdictions administering the test. The assessment and evaluation team is also considering additional avenues for benchmarking. One is to compare results on items from the current exam to results from TIMSS 1995 and 1999 exams where there is item overlap. This would potentially allow us to compare the MSP to the US, the international competitor group of countries determined for this region in 1999, and our region's 8^{th} grade results from the 1999 TIMSS Benchmarking. These strategies are currently being explored and results are not available as this report is being finalized.

The southwest Pennsylvania region has made good use of TIMSS results from as far back as the TIMSS 1995 administration and many math and science teachers are well aware of its design and applicability. Further, the Math Science Collaborative coordinated participation in the TIMSS 1999 Benchmarking project as a workforce region, randomly selecting a sample of 8^{th} grade students throughout the region.

Patterns of Student Course Taking in Mathematics and Science

In addition to monitoring achievement on standardized tests, the project is also monitoring students' participation in challenging mathematics and science courses as a measure of achievement. The *District Profile of Math and Science Indicators* is the source of these data. The profile is compiled annually from a survey that is distributed at the end of each academic year to 141 districts in the 11-county region, including all of the MSP districts. The profile collects data on course completion by graduating seniors in addition to current enrollment across all secondary grades in math and science courses. Due to NSF reporting requirements for the MSP project, the profile instrument was modified this year to request information on courses passed rather than courses passed with a C grade or better. This interrupted a series of consistent data dating back to the mid-1990s. Nonetheless, the data will serve as a baseline and we will monitor for increases in math and science course completion as the project moves forward.

In addition, the MSP districts can be compared to other districts in the region on the current profile. In general, the NSF MSP districts report slightly higher course completion than their regional peers. For example, NSF MSP schools report 91% of students having completed Level I Math (Algebra I equivalent) with a passing grade by graduation, compared to 89% in the region as a whole (which also includes the MSP districts). Biology I is the only course for which MSP districts reported a lower completion rate than the regional districts (91% vs. 92%). These data have not been analyzed for statistical significance. Trend data across prior years indicated a small but fairly steady increase in successful course completion of math and science courses in the region. With the change in data collection techniques in 2003-04, we cannot compare this year to prior years' data, although we will be looking at this more closely for trends in future years of the project.

7. Conclusions

Throughout this Year Two report, the logic model in Chapter 2 has been used as a unifying framework to discuss our findings. In this final chapter, we follow a similar pattern and organize our highlights and key findings within this structure, discussing some of the noteworthy elements within each logic model component. In the sections that discuss outputs and outcomes, we include questions that reflect our thinking about next steps and may assist the MSP in their strategic planning for Year Three. We are confident that the MSP staff will make use of this information in the most appropriate manner.

Inputs

The MSP utilizes a number of resources in setting the path toward achieving the intended outcomes. As noted in Chapter 2, the LATs are central in creating and utilizing the inputs as they guide the project's implementation in their institutions. They assess the status and capacity of their institutions using the Development Matrices, teacher confidence data, and student achievement data. Further, they create strategic plans, identify teacher leaders to participate in TLAs, and are responsible for determining the overall goals, timing, location, and means of support for participants in professional development activities. The work of the K-12 LATs is primarily accomplished during the Leadership Action Academies, which met four times this year. One of the concerns in Year One was ensuring that the LATs develop the confidence to act as leaders in their districts rather than relying too heavily on the MSP Coordinators. We found that for the most part the LATs are beginning to take this critical leadership step, especially in those districts with strong and consistent administrative involvement. Moreover, as a forum for planning and strategizing, the LAAs appear to be largely successful. While most LATs had attendance by a majority of team members, a few districts had fewer LAT members present due to scheduling conflicts or the inability of school and district administrators to be away from their districts for extended periods. These issues will most likely not resolve, and seem universal to most planning and professional development efforts in K-12 settings. Over the course of the evaluation, we will continue to monitor the ways in which these teams find alternative strategies to work effectively. We think this will provide important documentation for sharing within and beyond the project.

Intervention Strategies/MSP Activities

Completing the desired MSP activities is a critical first step in the path toward the intended outcomes. Therefore this report gave considerable attention to the ability of the MSP to carry out the planned activities, and also the quality of these activities. To this end, we found that the MSP was very successful, completing nearly all of the planned steps of Year Two. Of the few activities not completed, the responsible project team noted a rationale for the delay or cancellation of the activity. As was true in Year One, the process used for implementation planning and monitoring seems to work well for each of the teams to stay the course and complete appropriate activities with ample planning. In a similar manner, in

Year Two, the vast majority of MSP activities were implemented as planned, and were well received by participants.

With regards to the first intervention of professional development for leadership, we highlight the principal seminar, *Lenses on Learning*, as a very successful MSP activity. As detailed in Chapter 3, LoL is designed to provide an administrative infrastructure within the region for math and science reform. Similar to the TLAs, which are designed to inform teacher leaders about appropriate pedagogy and support for communities of learners in schools (both students and teachers), LoL has as its aim a deeper level of understanding of reform and the ways in which it can be supported by principals and other administrators.[27] Participants have reported high levels of satisfaction with the sessions and rate it among the best professional development they have received. In our principal survey, we observed some differences between principals who participated in LoL and principals who did not. Although our analysis cannot definitively link these differences to participation in LoL, the trend looks promising. Our follow-up principal survey will continue to monitor the influence of LoL. As a result of successes with the original LoL training that focuses on math education, the MSP staff has extended this professional development opportunity with an add-on module related to science education. Further, the MSP prioritized the importance of building administrative capacity for support by identifying LoL as a required "on-ramp" for expansion districts that plan to participate in the project in Year Three.

The TLAs were also quite successful in beginning the process of supporting teacher leaders. The TLAs helped teacher leaders develop a greater awareness and level of skill to facilitate professional development and to develop school-based teams of teachers for instructional improvement. The continuing school-year sessions of the TLAs have been completed and feedback from participants has been used in planning the second year of the summer academies to be held this summer. The school-based academies represent the next step in developing communities of learners in K-12 schools. However, as noted in Chapter 3, there were some difficulties implementing on-site activities as competing priorities in schools often jeopardize the actual scheduling and content of the professional development. We realize that for many of the districts this is a new experience and to some extent may reflect "growing pains." However, some of the difficulties may also reflect a lack of understanding or appreciation of the importance of these professional development activities among supervising administrators. Given the successes of LoL reported earlier, as more of the region's principals participate in LoL, these difficulties may resolve to some degree. However, creating and holding to scheduled time for professional development in K-12 settings is a struggle that presents a continuing challenge for this and many other educational reform initiatives.

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[27] As described more fully in Chapter 3, K-12 math coaches as well as student teacher supervisors from one IHE partner participated in LoL.

Outputs

Of the outputs listed in Figure 2-2, the primary one noted in Year Two was the increased interactions among IHEs, IUs, K-12 schools and districts. Although many activities may have contributed to this output, the TLAs and the TF program appear to have had the most direct impact. These are both important, high leverage MSP activities and they encompass very different strategies.

The academies reach a much wider audience and bring together many individuals. Although we noted that there were a few challenges with the TLAs, they were enormously successful in bringing the K-12 teachers and IHE faculty together and creating an opportunity for understanding the cultural differences between K-12 and IHEs. The TLAs were also quite successful in forming a strong foundation for the K-12 site-based learning communities discussed above.

The teacher fellow program utilizes a different strategy than the teacher leadership academies. Rather than bringing together large numbers of teachers and higher education faculty, the TF program encourages the development of relationships between an individual teacher and higher education faculty involved in the MSP. Thus, the intervention strategy has potential to create deep, lasting partnerships between higher education and K-12 schools and facilitate changes in both locations. Interviews with IHE faculty and TFs suggest that the program, at a minimum, facilitates revisions in IHE courses and the deepening of content knowledge and understanding of the Teacher Fellow. However, beyond refining courses, there is the potential for sustainable relationships that build on mutual benefit, such as co-authoring peer-reviewed articles, forming stronger connections between the IHE and K-12 school districts through targeted interactions between K-12 teachers and IHE faculty, and facilitating discussions in IHE departments about how best to teach future K-12 educators.

In order for the program's potential to be achieved, it is clear that a number of variables need to be carefully considered in the TF program. One of the primary considerations is the duration of the teacher fellow experience. TFs can choose one summer, one semester, or two semesters as options for their placement in IHEs. Although summers offer some clear advantages for teachers, this may not always be the best option. Fewer courses are typically offered at IHEs during the summer, and consequently, there are fewer opportunities to meet and interact with different faculty. Also, the possibilities for assisting in a course may be limited. Other variables that are equally important for consideration in the TF program include the academic preparation and background of the teachers, the seniority of the teachers, the engagement of the IHE faculty selected to serve as host mentors, and the selection of the courses to be revised. The decisions regarding the best way to consider these variables can be challenging, and some faculty members suggested that having an opportunity to interact with faculty from other IHEs would allow them to explore different ways to utilize the TFs. For the TF program to continue to achieve its primary goal of course revision, while also expanding the development of meaningful, sustained K-12/IHE partnerships, we propose the following questions for consideration:

- How can the MSP convince more teachers to spend a full year as a Teacher Fellow to encourage deeper relationships and opportunities for impact?

- Are there mechanisms that can be used to facilitate interaction among the four IHEs, specifically addressing best uses for and management of the TF program?
- The MSP expects TFs to return to their home districts for a year after completing their experience, but it is not clear that this policy is being enforced. How can the MSP ensure policy compliance?

Outcomes

Although it is too early in the project life to begin to see achievement of mid-term and long-term outcomes, examples of short-term outcomes are evident, such as increased awareness of cultural differences, increased partnerships and the use of data in decision-making. These outcomes and others were discussed in considerable detail in Chapters 4 and 5. Below we list some themes that emerged from our analysis of these outcomes. We believe that these themes are important to the continued achievement and sustainability of the outcomes described in our logic model.

Building capacity in schools that are most challenged

As indicated through initial case study data, some of the lowest implementing districts are also among the most challenged by educational burden and least equipped with existing capacity to support reform. This finding is not surprising and is documented in many reform and improvement initiatives. However, the MSP seeks to address schools across the spectrum of educational need and resources. As noted earlier, even in higher implementing schools, a key variable seems to be administrative leadership with a philosophical “buy-in” that leads to active support. This support seems especially tentative in these low implementing districts.[28] Questions for the MSP to consider include:

- Are different strategies and/or approaches needed for these districts? If so, what are they?
- Are the key leverage points different in these districts?

Clearly communicating intent and rationale

Communication is a key issue in a project as large and complex as the MSP. During the first year, the MSP partners all had to come together and understand a common conceptual “language” regarding the MSP. This appears to have been successful with all of the partners developing increased fluency. The core communication issues now center on clearly communicating intent and rationale, and as an outgrowth of these, roles and expectations. This issue is most apparent with individual IHE faculty, although it is possible that other partners have similar concerns. The questions we raise are:

- How can the MSP ensure that all participants understand their roles and responsibilities?
- How can the MSP best utilize all partners in planning and delivering MSP activities?

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[28] We note with hopeful anticipation that a change in leadership at one of the lowest implementing districts in the MSP seems to point to a strong positive shift in participation. We will continue to track this district as one of our case study districts in Year Three.

Linking the student teacher pipeline between K-12 and IHEs

An important strategy to leverage the capacity being built by the MSP in K-12 schools is to ensure that student teachers are exposed to the communities of teacher leaders being developed in K-12 settings. This can be accomplished through planned placement of these student teachers with MSP-participating teachers. This will afford student teachers opportunities to be mentored on the implementation of reform-oriented teaching strategies and to be fully supported in their first experiences implementing them. These student teaching experiences will help to improve the pipeline of new teachers feeding into the MSP schools and other schools in the region, thus ultimately building more capacity of highly qualified teachers in southwest Pennsylvania. IHE faculty indicate they are convinced of the benefits of this synergy, and are working to enact it; however, thus far the strategy has met with only limited success. District administrators, and the students themselves, often have discretion over student teacher placements and can undermine this planned strategy. Moreover, IHE faculty often have little influence over student teacher placement, as it is handled by a staff person or administrator. For the strategy to fully succeed, it is clear that more integrated and focused management of student teacher assignments will be needed.

- What can the MSP do to help all parties in the decisions about student placements become aware of and vested in enacting this placement strategy?

Balancing competing or conflicting incentives between K-12 and IHE

As mentioned in Chapter 4, both K-12 teachers and IHE faculty face a number of challenges to full participation in the MSP project. In addition, the incentive/reward structures of these two partners are not well aligned. For example, in IHEs, faculty members are rewarded for their publication records. Participating in projects such as the MSP may, in fact, be viewed as a distraction from the primary role of faculty and relegated to a low-level category such as "service." The potential positive impact of the MSP on IHE teaching practices is not widely recognized or is undervalued. Moreover, because IHE faculty are more likely to consider themselves experts in their content areas, there is little commitment to considering K-12 standards in their own courses. The collective cultural differences and potential disincentives may make partnership and true collaboration very difficult to build and sustain. We ask:

- What can the MSP do to help partners better understand and accommodate each others' cultural norms and expectations? How can the strengths from each community be considered as models for the other?

- How can the MSP assist in encouraging sustained partnerships between IHE faculty and K-12 teachers where both partners benefit equally?

Recognizing and allowing for time constraints

Any successful planning effort in education must consider time. Virtually all participants agree that time constraints are a hindrance to full MSP participation. This is a theme that appeared in Year One and has carried over into Year Two. Given this reality, participants must work at relieving the problem from both the supply and demand sides. Participants must acknowledge that in order to implement any major initiative it must be given priority, and time resources must be reallocated from other competing uses. The problem is particularly acute in the MSP model because major time commitments are intrinsic to the project design. Within this framework, sensitivity to time constraints is necessary in planning the times and venues where individuals might contribute, as well as in affording as much flexibility as possible in how participating K-12 districts and IHEs craft their implementations.

- How can the project relieve time constraints while remaining faithful to the MSP model?

Concluding Thoughts

At the end of Year Two, we find that the Math Science Partnership of Southwest PA has made considerable progress along the path toward achieving its goals. The resources and processes used to guide the MSP intervention strategies are providing the necessary infrastructure for the implementation of the MSP activities. Similar to Year One, the MSP has faithfully adhered to the implementation plan, completing almost all of the planned activities. Moreover, the activities appear to be well-received by the participants, providing teachers and administrators research-based materials and methods to further math and science learning in their districts and schools. Finally, we are beginning to see some expected outputs from many of these activities, such as the production of teacher leaders, changes in attitudes, understanding and awareness of both content and pedagogy, refined courses, and increased interactions among IHEs, IUs, and K-12 schools and districts. In the following years, our evaluation will begin to focus on the outcomes that derive from these outputs. Based on the current progress of the MSP, we are optimistic that many of these targets will be achieved as well.

Appendix A: Case Studies

Case Study Description

Case studies, in this evaluation design, are designed to add a depth of contextual understanding to additional data sources. By capturing a broader and more complete snapshot of the MSP from the school districts' perspective, we hope to be able to better situate and explicate findings from achievement data, teacher surveys and principal surveys, as well as interviews with MSP staff and IHE faculty. We are conducting 11 case studies, seven school districts from the National Science Foundation-sponsored group and four from those supported through the Pennsylvania Department of Education.

Districts were selected through a detailed process. Since one purpose of the case studies is to document a picture of MSP implementation with fidelity, as well as to document the reasons why some districts may not implement with fidelity, we gathered various early measures of participation and implementation. These included appointments of team members to each MSP intervention, attendance across opportunities, etc. Selection occurred late in 2004, so implementation was assessed from data available at that time. The five primary members of the evaluation team independently rank-ordered the list of districts while reviewing more than a dozen such implementation variables. Then the team discussed the rank orderings to look for similarities and discrepancies. Once a clustered rank order was agreed upon, we considered this along with a variety of demographic variables in selecting a stratified sample of districts. The district demographic variables we considered included size, location in the region, economic factors such as percent of students eligible for free or reduced-price lunch, and minority student population.

We classified the 11 districts selected for case study into three tiers. The five Tier 1 districts (three NSF, two PDE) are those that we designated as "low implementers." They have agreed to the proposed MSP project plans but have not completed all or most of the project requirements. One Tier 2 district (NSF) had been moderately successful in completing some of the project requirements and in attending some of the MSP activities. As the case study proceeded it became clear that this district had moved to a lower level implementation status and was thus reclassified as Tier 1. Five districts classified as Tier 3 districts are considered "high implementers." These districts have been successful in completing most of the project requirements and in attending a significant number of MSP activities.

The tier system was important in deciding how intensive the case study would be in each district. Since the focus of the Year Two case studies (Year Two is the first year of the case studies) was to be "successful implementation," we decided to spend more time in Tier 3 districts observing professional development sessions, doing some initial classroom observations for baseline portrayals, and following up with individual and group interviews of teachers, teacher leaders, and administrators (potentially this might include principals and central office staff). Tier 1 districts, because of their lack of implementation, often did not have any on-site professional development sessions or identified teachers to observe. The goal in the Tier 1 districts was to interview as many key participants as possible to best document the reasons for their lack of MSP involvement and implementation.

In developing instruments for observing professional development and classrooms, the team drew upon instruments developed by Horizon Research, Inc. and others for professional development and reform projects in math and science, such as the Local Systemic Change initiative and Looking Inside the Classroom. MSP project staff assisted the instrument development process by providing detailed reviews and descriptions of the kinds of pedagogy and professional development expected as a result of MSP intervention. Copies of the resulting instruments are available to project staff on request.

Case Study District Action

In late December 2004, the districts were notified of their selection for case study. Soon after, observers began communicating with the districts about their on-site professional development academies in order to schedule observation visits. Most contact with the districts occurred through the LAT point person. This proved challenging at times as it is often difficult to reach teachers, superintendents, or principals via the phone and some school districts still do not have widespread email access. Schedules varied from district to district and often changed at the last minute. In March 2005, we followed up with copies of interview and observation protocols.

In the Tier 3 districts, where possible, we attended one session of each of the elementary math, secondary math and high school science on-site academies. We also attempted to conduct at least six interviews with key project personnel, including LAT members and teacher leaders, and attempted to observe ten random classes across elementary and secondary math and high school science, because these are the disciplines and levels targeted by the on-site professional development. In most districts, we had to settle for fewer episodes of observation because of schedule conflicts. Two of our case study districts raised concern over classroom observations as a violation of existing teacher contracts. As a result, in these districts we observed classes of teachers who volunteered to be observed.

During the same time period, we also observed several TLAs in order to gain an awareness of the follow-up sessions that the teacher leaders attend. Additionally, for each case study district, we examined district files maintained by the MSP to document attendance and communication with project staff.

The AET and PI reviewed an initial summary of case study field notes in preparation for this report, and some findings from the case studies are identified herein. More extensive reporting is expected within the project next fall and in the Year Three evaluation report. Meanwhile, a second year of case studies will continue to document implementation but will also seek evidence linking MSP professional development to changes in the classroom.

Appendix B: Teacher Survey

The proposed project evaluation plan included a survey of math and science teachers in Years Two and Four of the project. It became clear, however, that we had to administer the survey in Year One to obtain baseline data. We reviewed existing survey instruments from several related studies of instructional practice such as Horizon Research's *Looking Inside the Classroom*, RAND's *Mosaic II*, instruments from Michigan State University's TIMSS Study Center, and the Council of Chief State School Officers' (CCSSO) *Surveys of Enacted Curriculum*. We selected the Surveys of Enacted Curriculum (SEC) based on their research-proven ability to measure the kinds of teacher practice and course content reforms targeted by the MSP intervention (Porter, 2002). However, because the SEC must be administered near the end of the academic year, and requires 60-90 minutes for completion, we were concerned about our ability to achieve acceptable response rates with the instruments in their current form.

In consultation with our colleagues at RAND and on the MSP Assessment and Evaluation Leadership Team, we determined that 30-45 minutes was a more reasonable length for this survey. Therefore, we modified the survey by deleting items so that the expected completion time would fall in this range. The criteria we used to determine which items to delete were based on the relevance of each survey item to the MSP intervention. We preserved those items that we expected to be impacted most strongly by the project. For course content survey items, the MSP's curriculum frameworks guided this effort. A pilot test was conducted to ensure that the modified instrument maintained coherence and could be completed in the targeted amount of time. Our modification of the SEC instrument was made with permission of the CCSSO, a partner in the development of the SEC. There are four versions of this survey, corresponding to the four versions of the SEC we began with, and they can be viewed online at the following URLs:

- K-8 Science: http://www.zoomerang.com/survey.zgi?p=UW36C2MHKQ
- High School Science: http://www.zoomerang.com/survey.zgi?p=UW36RAMRNL
- K-8 Math: http://www.zoomerang.com/survey.zgi?p=UW36RTMRYY
- High School Math: http://www.zoomerang.com/survey.zgi?p=UW36SDMSBY

The teacher population of interest for our survey was all teachers who specialize in math or science, as well as any teachers who teach at least some math or science. At the elementary level, this meant the population often included most teachers in the schools. We drew a random sample of 55% of the population for inclusion in the survey, with a slight overweight of teachers teaching in grades tested (3, 5, 8, and 11 in math and 4, 7, and 10 in science). This weighting was done to help support a statistical model where we link teachers with the test scores of their students.

The survey was conducted online, with a paper survey available to teachers who were unable or unwilling to complete the survey online. We received responses from 66% of the sampled teachers, and about 12% of these responses were on paper.

Appendix C: Principal Survey

The principal survey is designed to capture changes in principals' views and attitudes toward science and mathematics instruction; current practices and policies in curriculum, instruction, assessment, and professional development; district and IU support for improving schools; and MSP project impact. Survey items were adapted from survey instruments developed by Horizon Research, Inc., the Center for the Study of Teaching and Policy, and the Center for Research on the Context of Teaching; and principal rubrics developed by Richard Halverson at the Wisconsin Center for Education Research. We also shared early drafts of our principal survey with the PI and co-PI and received valuable input on refining the survey items to reflect areas of MSP impact.

The survey consists of six sections. The first two sections focus on views and influences on mathematics/science instructional practices and asked principals to provide their opinions on lesson design and implementation; instructional practices; classroom resources; assessment of student learning; government (federal and state) policies; regional/district policies; school policies; instructional materials and resources; and teacher support. Section III includes the most diverse set of survey items, with questions focusing on principal practices related to curriculum, instructional and assessment and a number of questions about the types of professional development activities principals participate in, including those offered by the MSP. Section IV, on district and IU support for improving schools, solicited principals' views on the extent to which districts and IUs facilitate supportive environments for many of the MSP promoted practices. Principals were also asked to rate the MSP staff's role to support school effort to implement MSP practices such as data collection and analysis, development of standards, and staff development. Section V focused solely on MSP project impact, asking principals to judge the impact of activities included in the MSP action plan. Finally, Section VI collected information about principal background, including items on content expertise, years as principal/assistant principal, ethnicity, and academic degree.

The principal survey can be viewed online at:

http://www.zoomerang.com/survey.zgi?p=WEB223WGPGN4GC

The principal survey was fielded online in late 2004, with paper surveys available to principals who requested them. The survey was distributed to 201 principals (one from each school associated with the MSP). The overall response rate was 70.6%, and 11% of these responses were on paper.

Appendix D: Higher Education Interviews

In March and April 2005, RAND researchers interviewed faculty members at the four partner IHEs and one faculty member from a consulting IHE. The Assessment and Evaluation Team developed the interview protocol with feedback from the MSP PI and the IHE Leadership Team. The protocol included questions about the faculty member's background, perceptions of the goals and objectives of the MSP, and role in the project. The interview then turned to discussion of partnership building; the impact of the MSP on the institution, the faculty, classroom pedagogy, and students; and the benefits of participation.

All interviews were conducted by two-person teams and lasted 30-60 minutes, with one person conducting the interview and the other taking notes and asking clarifying questions. Both team members reviewed the resulting notes for accuracy and completeness. Then, for each interview, the lead interviewer created a contact summary sheet summarizing the responses to each question, providing background information on the interviewee, and listing the main themes and questions that emerged from the interview. In turn, for each IHE the contact summary forms were used to develop a summary of all interviews at that institution. Team members who had not participated in the site visits assembled the summaries, and they were reviewed for accuracy by the lead interviewer.

A total of 28 interviews were conducted. At each IHE, six to eight faculty members were interviewed, including the IHE Leadership Team member, a Teacher Fellow, and a mix of math, science and education faculty. They included seven tenured, eight tenure-track, and nine non-tenure-track faculty. At least one-third of the faculty had previous K-12 experience ranging from two to 34 years as a teacher and/or principal.

Appendix E: MSP Event Observation

Part of the ongoing qualitative documentation of the MSP's implementation and impact includes the observation, both formal and informal, of various events and activities by members of the AET. In most cases, observations serve as secondary data sources as a way to confirm implementation, assess fidelity to planned activities, and gain awareness of the involvement of teachers and administrators across the project. These observations often raised questions for follow-up interviews with MSP staff, IHE faculty, and educators in case study districts. They also provide a deeper contextual understanding for the analysis from other primary sources such as the principal and teacher surveys. Notes from these event observations augmented other data sources in the preparation of this report.

An evaluation consultant attended LAA sessions held at Network Connections, one *Lenses on Learning* session at AIU, summer TLAs covering each level and discipline, and a number of on-site professional development academies in case study school districts during Years One and Two. The evaluation consultant used both narrative note taking and the Professional Development Observation Protocol to gather evaluation data. Additionally, MSP Coordinators, who facilitated the TLAs, completed a series of reflective questions related to lessons learned after conducting the summer and follow-up sessions of the TLAs.

The AET co-project director also attends monthly project director and cabinet meetings as a participant-observer. As such, the evaluator takes note of, in particular, evidence of data driven decision-making, organizational learning, and collaboration/partnership. Findings have helped to inform the development of this report.

Appendix F: Student Achievement

Data for the analysis of student achievement in Chapter 6 was collected from public data sources. School-level PSSA results were obtained from the Pennsylvania Department of Education,[29] and demographic information about schools was obtained from the Common Core of Data maintained by U.S. Department of Education's National Center for Education Statistics.[30]

Statistical Model for Current Analysis

The goal of the analysis presented in Chapter 6 was to determine whether individual schools are performing statistically significantly better or worse, in terms of percentage of proficient students, than would be predicted on the basis of the control variables such as socio-economic status, race/ethnicity, limited English proficiency, and geographic locale. The decision about whether or not a school is over- or under-performing must be based not only on how far the school's observed percentage of proficient students is from the predicted value, but also on how many students were tested in the school. If a relatively small number of students were tested, relatively large deviations from the predicted values might occur by chance alone, rather than true over- or under-performance.

We fit a generalized linear mixed model to carry out the appropriate tests of hypotheses. The model first calculates for each school the percentage of students that would have been proficient if the school had an extremely large number of students tested as a function of the control variables, and a factor specific to that school indicating whether the school is over- or under- performing. It then accounts for the fact that schools have finite, and differing, numbers of tested students when estimating all of these parameters. The models were fit in a Bayesian framework, which provided a probability distribution for each school's specific performance factor summarizing what the data were indicating that specific performance factor to be. Using those probability distributions we then assessed whether, based on the data, each school was appearing to over- or under- perform relative to similarly-situated schools.

Future Statistical Models

In future analyses, we plan to link teachers to the achievement of their students in a longitudinal model that will enable us to test the hypothesis that the MSP is impacting student achievement. Here we sketch some early thoughts on this type of modeling. In one option for this analysis, we might examine change over time in the aggregate scores of students in a teacher's class relative to changes to the responses on the teacher survey, accounting for classroom demographics, as follows:

$$\Delta class = \Delta teacher + \beta demographics$$

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29 http://www.pde.state.pa.us/a_and_t/cwp/browse.asp?a=3&bc=0&c=27525&a_and_tNav=|633|&a_and_tNav=|

30 http://nces.ed.gov/ccd/

Another option is to examine changes in students' individual scores between 2004 and 2007, given exposure to teachers who vary in their levels of participation in MSP activities, as follows:

$$y_{07} \mid (y_{04}, t_{07})$$

The data needed for this analysis, including information about teachers and teacher-student links, is more comprehensive than MSP districts agreed to when joining the project. The MSP is currently working to explain the rationale and benefit of providing the data, assure the protection of sensitive information, and guarantee anonymity in reporting, so that districts might be convinced to comply.

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