WORKING
PAPER

Math Science Partnership of Southwest Pennsylvania

Year Three Evaluation Report

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Preface

In 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 80 awards with over $500 million awarded to date, not including budgeted funds for future years in multi-year projects. 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 early May 2006. It provides a baseline description of the partners and a formative assessment of the project's progress and challenges. It is the third 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.

This working paper should be viewed as a companion to the Year Two annual evaluation report.[1] It builds on many of the issues and themes discussed in the Year Two report, but expands on them using new data and extended, in-depth analysis of previously collected data. However, because this is

[1] *Math Science Partnership of Southwest Pennsylvania: Year Two Evaluation Report* (www.rand.org/pubs/working_papers/WR270/). The Year One report, *Math Science Partnership of Southwest Pennsylvania: Year One Evaluation Report* (PM-1684-EDU), was published as a RAND Project Memorandum and is not available online.

considered to be a stand-alone document, much of the introduction and background information is similar to that presented in the Year Two report.

The study was conducted by RAND Education, a unit of the RAND Corporation, under a contract with the Allegheny Intermediate Unit.

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Summary

The Math Science Partnership of Southwest Pennsylvania (MSP) is one of seven comprehensive partnership projects funded by the National Science Foundation (NSF) in 2003. It includes 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 periphery 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.

The primary goals of this partnership are to increase K-12 students' knowledge of mathematics and science; to increase the quality of the K-16 educator workforce; and to 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 content and leadership* is accomplished through academies and seminars for K-12 educators and participating IHE faculty. The overriding purpose of these activities is to equip teachers with the pedagogical, 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*, which 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 evaluate the project. 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. To guide the evaluation, RAND identified the following four evaluation research questions that will be addressed over the course of this project:

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 third in a series of five planned 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.

Key Findings from Year Three Data

Our analysis of the Year Three data identified a number of key findings. We have organized our discussion of the findings using the MSP logic model framework of Inputs, Activities, Outputs and Outcomes.

Key Findings on Inputs

The Leadership Action Teams (LATs) offer important input which guides the planning and implementation of MSP activities. In the Year Two report, we noted that taking critical steps toward leadership and scheduling time to attend the Leadership Action Academies (LAAs) were issues that the K-12 LATs needed to address. In large part, these issues have been resolved, as the LATs have exhibited increased independence of the MSP coordinators and attendance at the LAAs has improved. However, the factors that account for LAT success remain elusive and appear to vary according to context. In most cases, a recursive process that includes administrative leadership and teacher initiative seems effective.

The LATs are also critical in IHEs, but it is more difficult to discern the underlying processes that account for the success of these teams. In some cases, these LATs were driven by a few individuals that were solely responsible for keeping faculty members involved. Other IHEs have LATs with more extensive faculty involvement. Both approaches seem to work well within the context of their institutions. As the project progresses we will continue to study how LATs are configured and the impact that has on partnership building.

Key Findings on Intervention Strategies/MSP Activities

Of the MSP professional development activities, the Teacher Leadership Academies (TLAs) continue to show improvement, with the academies demonstrating more integration of content-based pedagogy and leadership development in Year Three. As highlighted in the Year Two report, one strength of the TLAs is the opportunity they provide for direct interaction between K-12 and IHE faculty, which facilitates awareness and appreciation for different cultures.

The TLAs raise one key implementation issue: how teacher leaders will adapt the material for use in on-site academies. Due to time constraints, varying participation rates, and limited resources, teacher leaders often had to decide on short notice how to adapt these academies to conditions in their own schools. Although some degree of customization is expected, these adjustments raise questions about the degree to which these on-site academies can be modified while preserving the original intent. Because the on-site academies are a critical element in the development of communities of learners, the evaluation team will continue to monitor, through our case study districts, the types of modifications made to the on-site academies, the conditions that create them, and their impact of the changes.

The content deepening seminars (CDSs), though well-received, continue to face challenges related to marketing and participation by K-12 teachers. Specifically, CDSs were not well attended. One reason for this may be that teachers were at the end of a professional development credit cycle. Most teachers had accumulated the needed credits and the incentives for participation were low. Finding ways to encourage teachers to sign up for these IHE led seminars, rather than other seminars sponsored by other organizations (e.g. science museums, for profit teaching organizations), continues to present challenges for the MSP. This year the MSP attempted a number of efforts to increase participation in the IHE-led CDS, and it will be interesting to see if they are successful in increasing attendance. The IHE faculty members continue to try to identify unique ways to market and highlight the benefits of the CDS to the K-12 community.

Key Findings on Outputs

In addition to teacher and principal leaders, teacher fellows (TFs) are one of the major outputs of the MSP activities. While the other MSP activities and their outputs are aimed at reaching a broad audience of teachers, the TF program encourages the development of relationships between an individual teacher and higher education faculty. Thus, the TF program continues to be a critical link in building the partnership between K-12 and IHEs.

Last year we heard from fellows that spending a full year on an IHE campus was important in building relationships between participating IHE faculty and the TF. This theme was echoed in our TF interviews this year. Fellows who participated for a semester said that if given the opportunity again, they would opt for the year-long fellowship. However, factors such as being out of touch with their students, not really knowing what to expect from the experience, and concern over benefits had been important factors that they considered when making their initial decisions. Finding ways to address these concerns before TFs make decision about the duration of the fellowship may increase the likelihood that teachers will participate for a full year and gain the maximum benefit from the experience.

Key Findings on Outcomes

Although it is too early in the project to begin to see 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.

Variations in K-12 Participation

Patterns among the districts are beginning to emerge. One striking pattern is also a most logical one. Districts that show the most evidence of MSP impacts are those that are doing the most to implement the program, such as having high attendance at MSP activities, following project requirements, and providing teachers with an opportunity to reflect on what the MSP means within the context of their own teaching. Harder to discern is whether high levels of participation in the MSP are facilitated by certain district characteristics, making district involvement easier, or whether participating in the MSP strengthens certain district characteristics, making the impact of the MSP much more evident. It is difficult to answer this question at this early stage of our analysis.

Competing Reform Initiatives

Increasing teacher and administrator awareness of research-based practices and materials is an important early step toward changing practice. However, once teachers and administrators work to implement these practices, they must also contend with competing reform initiatives in their schools and districts. Data gathered in Year Three suggests that this was an issue for teachers, particularly science teachers, as they struggled to embrace their new understanding and awareness. Competing math reform initiatives as well as inadequate planning and preparation time for inquiry-based activities were common concerns. This issue may account for one of the trends we observed in the analysis of the teacher and principal survey data: responses from science teachers and responses from principals about science assigned lower ratings on a variety of activities than math teachers and principals responding about math. Whether the scale was measuring time spent on active learning, or emphasis of professional development on certain topics, the science responses ranked lower than math responses, with few exceptions. This finding is not surprising, and may in fact be a natural outgrowth of the emphasis on testing and accountability that is present in mathematics and not present in science. This should change as testing and accountability in science ramps up.

IHE Recognition and Value of MSP Impact

Sustainability of the partnership between K-12 school districts and IHEs depends, in large part, on the IHE's recognition of the benefits of participating in MSP. What are IHEs gaining as a result of participating in the MSP? Moreover, how do IHEs value the benefits they are receiving from the MSP? Interviews with IHE faculty members indicate that the one of the primary benefits is the exposure to pedagogy and, in particular, inquiry-based teaching practices. This was not a stated goal of the project, although it might have been a goal of some of the PIs in writing the grant. Perhaps they realized that IHE faculty would not be receptive to receiving professional development with K-12 teachers and the only way to bring them into the project was as experts. However, the unintended consequence of this may be improved teaching of undergraduates at IHEs.

Most faculty, particularly STEM faculty, receive little or no training to teach. Consequently they teach as they themselves have been taught, typically using a lecture-based format. As a result of MSP participation, faculty members have begun to incorporate concepts from the TLAs in their own classrooms. At issue, however, is whether there is an existing infrastructure within IHEs to recognize and to reward faculty for their increased awareness and change in teaching practices.

With regard to promotion and tenure, many IHEs view faculty participation in the MSP as community service. This method of recognizing MSP participation holds little value to faculty members because they can gain service credits through less labor-intensive methods than the MSP. Other IHEs are willing to recognize faculty participation in the MSP as research, provided that publications are forthcoming. For STEM faculty, this is a challenge, because publishing in one's own discipline is more widely acknowledged as scholarly research than publishing in other fields (i.e. science or math education). Furthermore, there are few mechanisms in place to reward faculty members for adopting pedagogical innovations acquired from MSP-related professional development. Moreover, junior faculty, who potentially have the most to gain from exposure to the MSP teaching strategies, are being discouraged from spending too much time on MSP activities because they are considered "risky" to their careers. Enhancing IHE recognition for MSP involvement is a key issue, not only for MSP sustainability, but for how the MSP communicates the value of its activities to the IHEs.

Managing Change

Year Three was a pivotal phase in the MSP. The first and second years of the project focused on establishing infrastructure, which required rather rigid adherence to MSP policies. Now, the MSP appears to be entering a phase that permits greater accommodation and flexibility. The MSP is also undergoing a change from a research and development project supported by the NSF to a more locally based education reform. This transformation will clearly be an area of interest for the evaluation team. A key component of this transformation is the MSP Coordinators, who are responsible for coordinating MSP activities in the district. As the project progresses, the MSP Coordinators will be supported by the IUs, who may have different expectations of MSP coordinators and their role in the districts.

With greater flexibility in response to K-12 and IHE partners comes added risk for a dilution of the MSP program and theory of action. As the MSP adapts to accommodate institutional contexts (a necessary step for sustainability), it will be important to consider fidelity of implementation in regard to outputs and outcomes as well.

Communication

Communication between partner institutions remains an important issue. During Year Three, there was evidence of continued improvement in communication between IHE and K-12 partners. However, there was room for continued improvement. Some K-12 and IHE participants still perceived the program as non-responsive to specific needs . Given the scope and scale of the project, some confusion may have to be tolerated as inevitable; the project will need to come to terms with how much misperception it can accept and what threshold must be crossed to signal a problem.

Linking the Student Teacher Pipeline between K-12 and IHEs

Student teachers need exposure to the communities of teacher leaders being developed in K-12 settings. This exposure 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. Student-teaching experiences will help 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 members 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 who may not be closely involved in the MSP. For the strategy to fully succeed, more-integrated and focused management of student teacher assignments will be needed.

Individual and Institutional Partnership

One theme that emerged from the IHE interviews was the view that partnerships are complex and that building them is the responsibility of all involved in the MSP. Institutions can only do so much to foster partnership between individuals and similarly individuals cannot force institutional partnership. A key question about sustainability is whether the individual relationships that have been built will continue after the NSF funding period is complete. Relationships take time to maintain, and if they are not valued by the institutions, there may be insufficient motivation for the partnerships to continue.

Student Achievement

The most current achievement data are from early in the project's implementation. Statistical models assessing change in MSP districts' PSSA math proficiency relative to a group of matched Pennsylvania school districts revealed no evidence of project impact at this early stage. The same analysis did find a statewide trend of increased proficiency on the PSSA, a fact that is useful when interpreting benchmarking trends, where more districts are meeting the math targets set by this project. There is no clear trend in science. Over the next two years the evaluation will place increased focus on achievement outcomes and, to the extent possible, developing plausible explanations for how the MSP project has influenced achievement.

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Acronyms

Acronym	Definition
AET	Assessment and Evaluation Team
AIM	Analyzing Instructional Materials
AIU	Allegheny Intermediate Unit
CBAM	Concerns Based Adoption Model
CCSSO	Council of Chief State School Officers
CDA	Comprehensive Data Analysis
CDS	Content Deepening Seminar
IHE	Institution of Higher Education
INTERACT	Invitation to Effectively Reflect and Collaborate Time
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	No 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
RETA	Research, Evaluation, and Technical Assistance
SEC	Surveys of Enacted Curriculum
STEM	Science, Technology, Engineering, and Mathematics
SWOT	Strength, Weakness, Opportunity and Threat
TF	Teacher Fellow
TIMSS	Trends in International Mathematics and Science Study
TLA	Teacher Leadership Academy

1. Introduction

Overview of the Math and Science Partnership Program

The National Science Foundation's (NSF) Math and Science Partnership program was an outgrowth of the No Child Left Behind (NCLB) Act of 2001. The program was developed largely in response to growing concerns about the ability of the U.S. to remain competitive in a global economy given 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.

Previous NSF programs targeting math and science educational reform have had similar goals. However, the Math and Science Partnership program is notable for including higher education 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 institution of higher education (IHE) 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. 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 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 (RETA) 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.

NCLB also authorizes a parallel Math and Science Partnership program at the U.S. Department of Education. 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 describe 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.[2] 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 that it does not endorse a "one size fits all" evaluation model.[3]

The Math Science Partnership of Southwest Pennsylvania

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 partner Intermediate Units (IUs).[4] The NSF award supports 40 of the

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

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

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

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) near Pittsburgh, the central IU representing also the greatest density of school districts in the region.

Evaluation Design and Implementation

The AIU subcontracted with the RAND Corporation and the University of Pittsburgh to serve as evaluators for the project. RAND's evaluation of the MSP is designed to monitor the project's 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. To guide us in this evaluation, 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. These 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?

To address these research questions, the study adopted 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.

Year Three Data Collection and Analyses

Data collection and analysis activities for Year Three included the following:

- **Observations of MSP events.** 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 evaluation team. 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 and case studies. Event observation data augmented other data sources and are presented in Chapters 3, 4, and 5 in this report. Further details about the MSP event observations can be found in Appendix E.

- **Interviews and focus groups involving key project personnel**. The evaluation plan included an interview with the principal and co-principal investigators of this project as well as a focus group with the MSP Coordinators. The PI interview was conducted with both of the investigators during a lunch meeting. MSP Coordinators[5] were given the opportunity to have either an individual interview or be part of a focus group interview. All but one coordinator requested the group format. The focus group with the MSP Coordinators was completed in two hours, and the PI interview in approximately 1 hour. The interview protocols addressed such issues as PI and Coordinator roles and responsibilities, project sustainability, and district challenges and successes. These data are primarily presented in Chapters 3 and 4.

- **Interviews with IHE faculty, deans, and current teacher fellows[6] at IHE campuses.** In April 2006, RAND researchers interviewed faculty members, deans, and current teaching fellows at the four partner IHEs. Each interview was conducted during a one-day visit to the campus. The interviews included at least one dean, a IHE team leader, a teacher fellow, a least one faculty member from education, math, and science. In addition, we interviewed at least one faculty member who had significant participation in each of the MSP activities (i.e. teacher leadership academy, content deepening seminar, supervising a teacher fellow and revising a course)[7]. Seven interviews were conducted on each campus, except for one where we conducted eight interviews. Each interview included general questions about the MSP, partnership, impact, and sustainability as well as a series of questions on participation in a specific MSP activity. Faculty selected for interviews were generally the ones who were most active in the MSP. This determination was based, in large part, on information faculty members provided to the MSP Management Information System[8] regarding their participation in the project. IHE interview data are primarily presented in Chapters 3 and 4.

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[5] MSP Coordinators are defined in Chapter 2.

[6] Teacher fellows are K-12 teachers who spent time on IHE campuses as part of their participation in the Teacher Fellow program which will be discussed in more detail in Chapter 2.

[7] Each of these MSP activities is described in more detail in Chapter 2.

[8] The MSP Management Information System is an annual survey sponsored by the NSF MSP program, which collects information from each MSP-funded project. This information is used to describe the implementation and impact of the MSP program and monitor the progress of individual MSP awards.

- **Case studies**. The case studies included twelve K-12 districts -- seven districts supported by the National Science Foundation MSP and five from the Pennsylvania Department of Education MSP. The Pennsylvania Department of Education added one more district in Year Three due to the lack of participation by one of its original case study districts. Case studies included observations of on-site professional development, classroom observations, and interviews with teacher leaders, classroom teachers, and school administrators. Further details about the case studies are provided in Appendix A. These data are primarily presented in Chapters 3, 4, and 5.

- **Extended analyses of survey data from K-12 teachers of mathematics and science and principals.** In 2004, we gathered survey data from principals and K-12 teachers of mathematics and science.[9] The data from both the teacher and principal surveys are considered baseline, since the information was collected either prior to or early into the implementation phase of MSP activities. The Year Two report summarized information from some of the items on these surveys. The current report presents subsequent results from a factor analysis of the survey data. The goal of the factor analysis was to identify subsets of the individual survey items that are highly correlated and to combine these items into a smaller number of reliable scales that can be used in quantitative models. The baseline values of these variables can be used as independent or predictor variables for project outcomes; and after the repeated administration of the surveys in Year Four of the project, changes on these scales can be assessed as dependent variables that measure project outcomes. The results of these analyses are presented in Chapters 4 and 5, and technical details of the factor analysis process are described in Appendix D.

- **Analysis of student achievement data**. An analysis of achievement data employed a comprehensive database of Pennsylvania school districts to form a comparison group that was similar to the MSP districts in 2003, at the time the project began. In particular, the comparison group is similar to the MSP districts on important variables that are frequently observed to predict future achievement, including prior Pennsylvania System of School Assessment (PSSA) math and reading scaled scores, the trends of change in those scores, income, race/ethnicity, attendance and graduation rates, geographic locale and educational attainment of adults in the community. The matched comparison group was then used in statistical models to estimate whether the MSP project affected the 2005 PSSA results in participating districts. The 2005 PSSA exams were administered somewhat early in the implementation of the MSP but are the most current test results available to date. This analysis is presented in Chapter 6, and additional technical information appears in Appendix F.

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[9] The teacher surveys were adapted from the Surveys of Enacted Curriculum (SEC) (Porter, 2002) and the principal survey included items 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. Additional details about these surveys are provided in Appendices B and C.

Table 1-1 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. The table also indicates how these data collection strategies are related to the research questions and how frequently the data are being collected. Full copies of the protocols and instruments are not included in this report; however, they are available to project staff and other interested parties on request.

Table 1-1: Evaluation Study Design

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

Purpose of this Report

This report is the third 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, this report sets out 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, the reporting and analysis of these data will be an important component of future analyses.

Limitations of the Study

This evaluation is designed to be selective in its data collection and analyses, primarily assessing the project's achievement of its goals and the major pathways toward achieving those goals. However, this focus implies that some aspects of the project (e.g. a detailed understanding of the project's impact on instruction at IHEs) are not included in the evaluation design. A limitation of this study is that the MSP project is not being implemented as a randomized experiment with a control group, and this fact will limit the ability to make causal claims about the MSP's impact. In seeking to understand the impact on student achievement, the evaluation is hampered by the lack of a statewide science test. The project is administering a science exam for the purposes of this study; however the exam is not administered widely outside the project, leaving few options for comparing the science performance of MSP districts to external references such as comparison districts. Moreover, until recently, a math test was administered to students in only a few grade levels, limiting the evaluation's access to baseline math achievement data for all students. At the conclusion of this five-year evaluation, delays in reporting of achievement data may force the evaluation to confine its analyses to test results through the 2006-07 academic year, covering only three full years of MSP implementation in the school districts. If the MSP intervention requires more than three years to affect achievement outcomes, the evaluation may not be able to detect this impact. To supplement and illuminate the quantitative analyses, the project relies heavily on qualitative self-report data, through surveys, interviews, and focus groups. This data is subject to bias if respondents answer inaccurately or if the sampled districts for case study are not representative. The analyses discussed in this Year Three report are further limited because the currently available data come from very early in project implementation, before there has been sufficient time for project impact. Additional details about the limitations of specific analyses are described in context throughout this report.

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. It also provides an updated logic model of the MSP, which details the three major intervention strategies and the intended outcomes from the MSP activities. Chapter 3 describes the implementation of Year Three MSP intervention activities. Chapter 4 presents findings related to institutional practices and support structures that were 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, discussing some of the factors influencing changes in teacher instructional practices. 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 used in the course of this evaluation.

2. Overview of the Math Science Partnership of Southwest Pennsylvania

This chapter provides an overview of the Math Science Partnership of Southwest Pennsylvania, describing the partners involved in this project, the intervention strategies and activities of the project, and the motivation for and organization of the partnership. It discusses refinement of the MSP logic model, which was developed in the second year of the study, and describes how elements of the logic model relate to the research evaluation questions.

Description of the Partnership

The region of Southwestern Pennsylvania that is served by the MSP includes the urban fringe of the City of Pittsburgh, several smaller urban areas, suburbs, and rural areas.[10] Total enrollment in the MSP school districts is approximately 114,000 students, with approximately 3,800 teachers who teach math or science topics. On average, about 39% of students in MSP schools are economically disadvantaged,[11] 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[12] 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 wide variation in student achievement levels across the MSP. A substantial portion of MSP schools are not making adequate yearly progress under NCLB; three 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.

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. Six districts will be added as expansion

[10] 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.]

[11] As is common practice, we use free or reduced-price lunch eligibility as a proxy for economic status.

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

sites beginning in Year Four. Although ten districts initially expressed interest in joining the MSP, only six fulfilled all of the prerequisites.[13] In Year Four, the six expansion districts will join the other districts in the project as full partners.

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 universities were 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 content and 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* , which 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.

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[13] The prerequisites for expansion districts to join the project include the following activities: (1) sending three administrators (one elementary, one secondary, one central office) to the 2005-06 Lenses on Learning training; (2) appointing a Leadership Action Team (LAT) and bringing them to the February session 2006 of Network Connections; (3) sending a letter of commitment from the Superintendent; (4) making full appointments to the Teacher Leadership Academies for summer 2006; (5) administering the PROM/SE science test for baseline data; and (6) providing all of the required achievement and demographic data required in the project. These activities are described later in this report.

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 three-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—who receive training, then return to their schools and lead in-school professional development efforts—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 creating 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. These academies are specialized by discipline and grade ranges (either K-8 or high school). Professional development for teacher leaders, who then share their experiences 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 limited to teachers. District principals gain a deeper understanding of effective instruction and develop observation 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 PROM/SE assessment administered by this evaluation project[14]; results from the project's survey of teacher confidence in math and science content areas; results from the District Profile on Course Completion; 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 annually assess their districts using 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 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 teaching fewer concepts in more depth, with less repetition from year to year.

At the IHE level, course refinement 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

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[14] Currently, there is no statewide science exam in Pennsylvania. See "Student Outcomes" in Chapter 6 for more information about the PROM/SE science assessment.

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 an important activity within the MSP as it addresses a number of goals. In addition to course revision and refinement, participating teachers receive professional development 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 its 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 values that inform the MSP, 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.[15] Later, in 1997, the importance of standards was reinforced with the publication of the Trends in International Mathematics and Science Study (TIMSS) results. The TIMSS results were pivotal to the origination of the MSP, as they demonstrated the importance of standards in setting clear goals and encouraging collegial discussions. Later, when the Math and Science Partnership program was announced, the MSC identified it as an opportunity to strategically apply what was learned from TIMSS as a focus for change in southwest Pennsylvania.

Many of the current MSP activities, such as Network Connections and the Teacher Leadership Academies, originated in 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

[15] The National Council of Teachers of Mathematics (NCTM) produced the Curriculum and Evaluation Standards for School Mathematics in 1989. The National Research Council (NRC) produced the National Science Education Standards in 1995.

successful, and by 1998 most districts in the region had participated. These experiences with 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.

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* 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 due to other commitments; 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 consists of a governing board known as 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. 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 partially support the co-directors of the Assessment and Evaluation Team. 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. The MSP Cabinet meets monthly.

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. 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 coordinators are responsible for connecting K-12 districts to IHEs and for implementing MSP activities. The coordinators bring a wealth of experience to the MSP as indicated by their diverse backgrounds: retired, late career, and early-career K-12 teachers, K-12 administrators, and a community college teacher. The 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 coordinators and their work is primarily under the supervision of the MSP PI.

MSP Logic Model and Theory of Action

We developed a logic model to illustrate the interrelationships among the MSP program's goals, activities, and structure. Logic models are common evaluation tools, and offer visual representations of a program's path to achieving its intended outcomes. The model not only describes the MSP project, but also furnishes the evaluation team with a unified set of terms and relationships to facilitate discussion and thinking about the MSP project. We view the logic model as a work in progress that evolves with our thinking and analysis of the MSP project. The current version of the logic is shown in Figure 2-1. It includes the traditional components of inputs, activities, outputs, and outcomes. However, in the third year of the project we added, reworded, deleted and revised elements within each of the major component headings. In the following sections, we describe each component of the logic model diagram, moving from left to right.

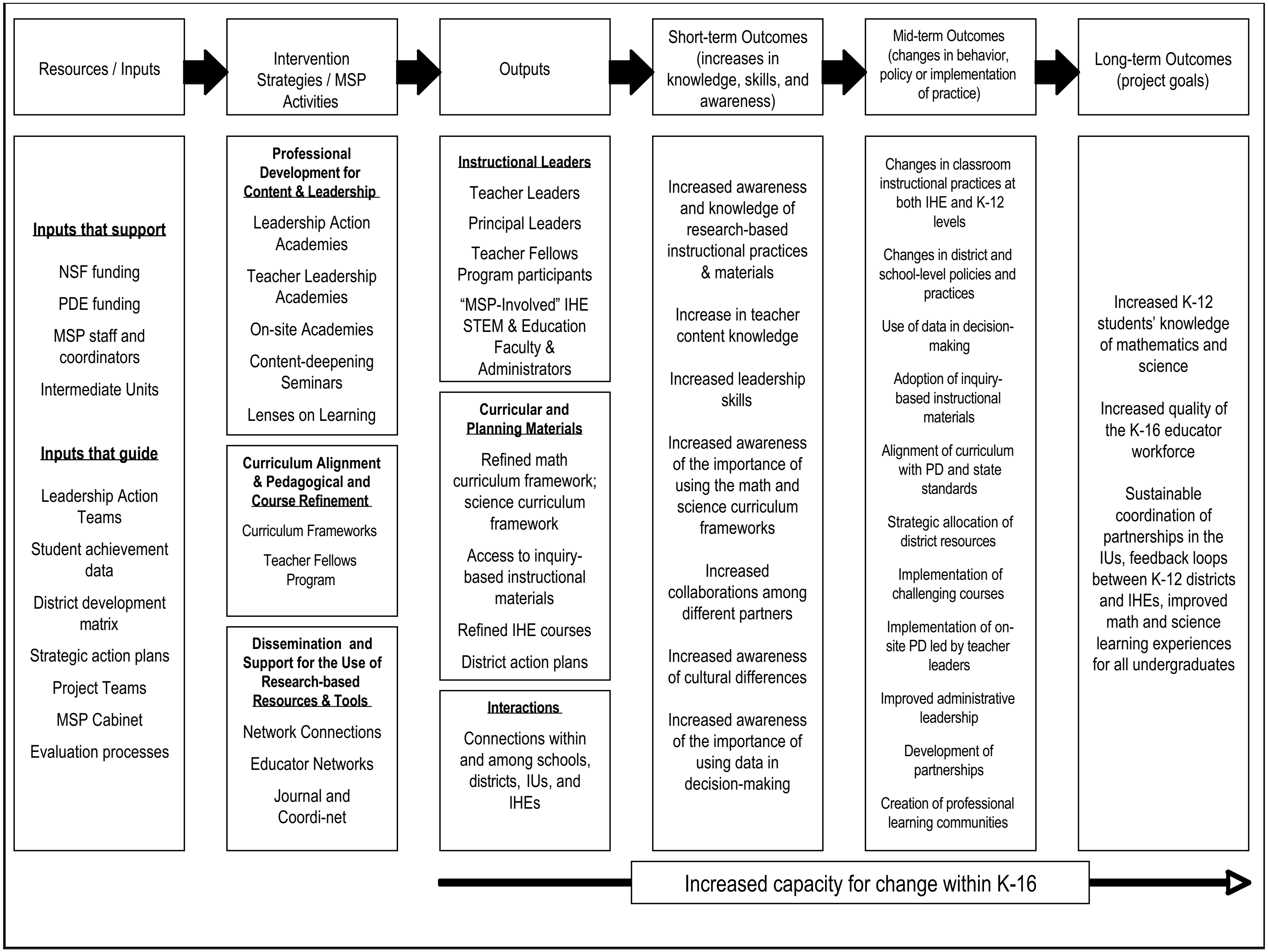

Figure 2-1: MSP Project Logic Model

Resources / Inputs

Inputs are the resources that support or guide the MSP activities. These include not only funding and human resources, but also materials and expertise that guide MSP activities. The NSF and PDE provide the primary funding to support the MSP activities. MSP staff, including the MSP Coordinators, facilitates 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 profile of course completion, 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 are also key in providing information that contributes to setting the direction of the MSP activities.

Intervention Strategies / 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 MSP activities. These have been reorganized in the current version of the logic model. As we continued to reflect on the MSP, we concluded that the major outputs from the MSP activities were 1) individuals' exposure to skills and knowledge-enriching activities, which positioned them as leaders; 2) materials/tools that could be accessed and utilized for courses, curriculum and district planning; and 3) opportunities for interactions and networking. We refined these ideas using terminology consistent with the MSP. "Instructional leaders" describes the cadre of individuals who have participated meaningfully in MSP activities. "Curricular and Planning Materials" refers to the curriculum frameworks, the inquiry-based materials available for districts, the IHE courses that have been refined as a result of the Teacher Fellow program, and the district action plans, used to guide the districts toward improved student achievement. Finally, "interactions" refers to all of the connections among the partners. Note that there is not an exact one-to-one correspondence between the MSP activities box and the Outputs box. For example, MSP activities listed under "professional development for content & leadership" not only produce instructional leaders but they also provide access to inquiry-based instructional materials.

Outcomes

The next three columns list the expected outcomes that derive from these outputs. This updated version of the logic model defines short-term outcomes as increases in knowledge, skills, and awareness. Mid-term outcomes, then, are the changes in behavior, policy, or practice that occur presumably as a result of the increases in knowledge, skills, and awareness. Many short-term outcomes describe the kinds of increases in knowledge, skills, and awareness that are *expected* for the instructional leaders. For example, we expect to see evidence of increases in awareness and knowledge of research-based practices and materials, teacher content knowledge, and leadership skills. However, the evaluation will determine the extent to which this has been achieved. The mid-term outcomes category of the model is more complex, because it reflects the changes that are expected to occur at various levels. For example, in the classrooms, we expect to see changes in instructional practices. In the schools, we expect to see changes in school-level policies such as curriculum alignment and adoption of inquiry based instructional materials. At the district level, we expect to see improved administrative leadership, implementation of on-site PD led by teacher leaders, and strategic allocation of district resources. Finally at the partnership level, we expect to see the creation of professional learning communities for both K-12 and IHEs. These changes are not all equivalent. Changes in behavior may be easier or more difficult to effect than changes in policies. Moreover there may be interdependencies among the changes listed in this column. For example, improved administrative leadership may need to precede changes in district and school-level policies and practices. Changes in classroom instructional practices at the IHE level may need to precede the implementation of challenging courses. Collectively, the changes described in the mid-term outcomes should lead to the achievement of the project goals, which are defined as the long-term outcomes.

Theory of Action

The theory of action that underlies the MSP logic model is premised on the view that student achievement in mathematics and science can be enhanced by administrators and classroom teachers who are willing to become learners and deepen their own conceptual understanding of the big ideas in mathematics and science.[16] Similar to the theory of action for the NSF-supported local systemic change, this theory of action argues that providing teachers with opportunities to deepen their content and pedagogical knowledge in the context of high-quality instructional materials will result in better prepared teachers. With ongoing support, teachers will be more inclined to change their instruction in ways advocated by national standards, and will have more capacity to do so. Improved instruction will, in turn, lead to higher student achievement.

This theory of action is supported by a number of research studies. In particular, Catherine Lewis's seminal work on lesson study and research by Japanese and U.S. educators has outlined key pathways to

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[16] Math & Science Collaborative Journal, v11, p.20.

instructional improvement, most of which are mirrored in the MSP logic model. These key pathways include: increased knowledge of subject matter; increased knowledge of instruction; increased ability to observe students; stronger collegial networks; stronger connection of daily practice to long-term goals; strong motivation and sense of efficacy; and improved quality of lesson plans.[17] Thus the intervention strategies that the MSP has employed provide mechanisms for achieving program goals along each of these pathways. Content deepening seminars are the primary routes to achieving increased knowledge of subject matter. The teacher leadership academies are the main route for achieving increased knowledge of instruction. Stronger collegial networks are built via a number of routes, including participation in Network Connections; district led on-site PD academies; and Educator Networks. The emphasis on curriculum alignment and pedagogical and course refinement offers opportunities to improve the quality of instructional materials and lesson plans. However, in addition to these pathways, the MSP theory of action also argues that support from district leadership is an important component of instructional improvement. Administrators can play a significant role in supporting teacher-led instructional change, especially with regards to scheduling time for professional development, obtaining substitute coverage for teachers participating in professional development, and allocation of funds. Thus, Lenses on Learning is a key intervention strategy for involving and gaining administrator support. Finally, the role of the IHE in the MSP theory of action is based on the belief that partnership between K-12 and IHEs is mutually supportive and can enhance learning, cultural awareness, and teaching practices for both partners.

Relationship between Logic Model and Evaluation Questions

Both the MSP logic model and research evaluation questions provide a framework to guide the evaluation. The first research evaluation question addresses the need to provide formative assessment and documentation of MSP activities and corresponds primarily to the Intervention Strategies and MSP Activities listed in the logic model. However, the discussion of MSP activities also has implications for the Inputs and Outputs. The successful implementation of the MSP activities depends on the resources available to generate these activities. Moreover, successful implementation of MSP activities is reflected in the Outputs that are generated. For the MSP, this is evidenced by the quantity and quality of instructional leaders, curriculum materials, and opportunities for interactions. The second and third research evaluation questions assess some of the key outcomes of the MSP — changes in institutional practices, changes in support structures at both the district and IHE levels, and changes in instructional practices at the classroom level. Although these questions primarily track the Mid-term outcomes in the logic model, the Short-term outcomes are important precursors that indicate the likelihood that these Mid-term outcomes will be achieved. Finally, the fourth research evaluation question focuses on the bottom line of student outcomes and changes in course taking practices. In essence, this question is

[17] Lewis, C., R. Perry, and J. Hurd (2004), A Deeper Look at Lesson Study, Educational Leadership, February 2004, p.18-23.

asking whether the project achieved its goals, which are outlined in the Long-term Outcomes in the logic model. One of the most important aspects of our assessment will be to determine whether achievement of these Long-term outcomes can be linked to MSP activities. The discussions in Chapters 3 through 6 are organized around this integration of the research evaluation questions and the logic model.

3. Implementation Strategies and Activities through Year Three

An important goal of the evaluation is to provide formative assessment to assist the MSP in determining whether it is on track or needs to make mid-course adjustments in order to achieve the intended outcomes. This chapter provides this assessment to date. It addresses the first of our evaluation research questions: Have MSP partners developed and implemented a comprehensive intervention targeting math and science curriculum and achievement? If so, how?

To answer this question, the chapter highlights the activities of the MSP during the first nine months of Year Three,[18] paying particular attention to whether the project is unfolding as planned in the proposal and, where applicable, discussing areas of change and evolution.[19]

Overview of Intervention Strategies

As described in the logic model in Chapter 2, the MSP uses three intervention strategies to achieve its goals. These three strategies are professional development for content and leadership; curriculum alignment and pedagogical and course refinement; and dissemination of and support for the use of research-based resources and tools. Although the logic model is useful in portraying 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. As evidence of implementation, this section provides a more detailed account of each of the intervention strategies and the activities that support them. Each strategy includes planned activities that constitute the overall project implementation plan. This highly detailed implementation plan contains hundreds of action steps for the teams and staff of the MSP. Over the life of the project, major strategies remain consistent, though the specific activities included within each strategy change and/or shift in priority.

As discussed in Chapter 2, the intervention strategies and specific activities are designed to produce outputs that lead to short-, mid- and long-term outcomes. These outputs include instructional leaders in K-12 and IHE settings, curricular and planning materials, and interactions among schools, districts, IUs and IHEs.

The following sections describe the implementation activities undertaken during Year Three that correspond to each of the three major strategies. For each of the strategies, the section: describes the key

[18] The project commenced in September 2003. A review of Year One and Two activities and the evaluation materials related to those activities can be found in those prior evaluation reports, as well as the project's full annual progress reports.

[19] A project calendar with specific dates and information about each activity is available on the project website http://www.aiu3.net/msc

components of the intervention strategies, describes Year Three activities, summarizes participant feedback and reactions, and discusses ongoing issues.

Professional Development for Content and Leadership

A prerequisite for change is developing a capacity for change. Thus, a major component of the MSP is to build the capacity for change through professional development for leadership, for K-12 teachers and administrators, as well as through the involvement of IHE faculty in math, science, and education. The MSP model of professional development for leadership includes needs assessment and planning by teacher leaders and administrators, school-based communities of learners, and on-site academies designed to disseminate and support pedagogical change more broadly. IHE faculty members offer links to more extensive content knowledge and serve as hosts, advisors, and workshop developers and presenters. Each of the major activities related to Professional Development for Content and Leadership is described and the Year Three activity is summarized below.

Leadership Action Academy

The Leadership Action Academy (LAA) aims to equip K-12 teachers and administrators with the capacity to lead professional development. K-12 Leadership Action Teams (LATs) from each district convene 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 consist of an administrator, a guidance counselor, and six teachers, including one math teacher and one science teacher at the elementary, middle school, and high school levels. During the second year of the project, there were four plenary meetings of these LATs, in addition to 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 Years Two and Three, 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.

In 2003, the LATs from each MSP school district were asked to complete a strength, weakness, opportunity, and threat (S.W.O.T.) analysis based on the following information: 2003 PSSA mathematics scores by grade level (grades 5, 8, 11); PROM/SE test results in science; the District Development Matrix, Teacher Content Inventory; the Math and Science Collaborative District Profile of Math and Science Indicators; and the District Context Information. In both 2004 and 2005, using current data generated from these sources, districts reviewed and revised the action plans to better inform decisions on "next steps."

The IHE partners also have LATs that meet as needed for planning and development purposes. Some meet quarterly, others monthly, depending on the institution's choice. During Year Three, IHE faculty in the LATs served as links in connecting the MSP with the IHEs. Faculty on the LAT described their role as consisting of three categories of activity; coordinating, planning and disseminating — coordination of IHE involvement in MSP activities, planning the activities for the upcoming year, and disseminating information on MSP activities to other faculty within their institutions. Participating IHE faculty also described their role as a connection among math, science and education faculty. One IHE faculty member summarized this role as "opening the door between education and math and science faculty." Additionally, the project serves as a conduit for information about education (both K-12 and IHE) for math and science faculty since, unlike their peers in education; they do not typically have contact with people in K-12 schools. Some faculty also mentioned connections that were developing across math and science disciplines as a result of their involvement with the project.

Most participating faculty said these connections within and among institutions should be sustained. However, whether that activity would need to be accomplished through the LATs was unclear. During Year Three the LATs decided to sponsor a series of "Dean's Dinners" to better inform and garner the support of academic deans from each partner institution. These meetings seem to have helped deans engage in cross-institutional discussions. Most notable is the continuing conversation (involving deans and faculty) on the appropriate placement of MSP participation within the portfolio of a candidate being considered for promotion. Rank and tenure expectations and conflicts occur for STEM faculty when their involvement with MSP K-12 schools is considered "service," which typically is considered less valuable than scholarship for purposes of promotion. This continues to be an important issue that influences faculty participation in the MSP.

During Year Three, the K-12 LAAs met and included representation from 45 of the 48 MSP districts. Lead administrators are considered important members of the LATs since they often influence resource distribution, scheduling, and priorities. Project records indicate that during Year Three, lead administrator participation in the LAAs decreased for half of the 40 MSP districts, increased for 10 and remained constant for 10. Overall team participation from districts remained steady for 23 of the districts, decreased for 14 and increased for 5 districts. These changing patterns in participation may reflect a shift in support for the MSP; however, a number of competing and complicating factors may also be influencing commitment and participation to the LAAs. Case study data indicate that competing priorities often spread administrator attendance and participation across numerous initiatives. So too, it is becoming increasingly difficult for teachers to leave their classroom appointments to engage in planning and professional development. Substitute teachers are difficult to find and the press for measured accountability in a subset of disciplines tends to produce a narrowly defined prioritization for activity.

Those people and teams that did participate report a very high degree of satisfaction and productivity during LAA meetings. At a culminating session (Day 4) during Year Three, participants were asked to discuss and chart their responses to several questions: 'What tools and strategies have you gained to strengthen student learning through the MSP? If possible, please reference from which MSP activity you gained them', 'How do the activities of the MSP provide tools and strategies for teachers to address the MSP aims?', and 'How do these tools and strategies address the accountability challenges facing educators?' Team members were grouped with members of other teams holding similar roles. After each of these groups created a chart, participants were assembled a second time into "touring groups" that moved from chart to chart. As each touring group arrived at a chart, one of the touring group members who helped to create the chart explained it to the rest of the group. Based on feedback and observations, this activity was an effective strategy that enabled participants to see the commonalities across the groups, as well as helping the administrators understand the nature of the learning provided by the TLAs. Participants noted positive impact from their involvement across a variety of MSP activities rather than only one or a few select activities. As the project matures, it seems that participants are not only appreciating the individual components, but also beginning to experience the synergistic benefits of the complementary activities which comprise MSP implementation.

One of the activities of each K-12 and IHE LATs 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). Teams review evidence-based rubrics to systematically determine their placement across years of the project. The box-and-whiskers plots in Figures 3-1 and 3-2 show 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 Three of the project. The IHE teams used a similar process with matrices in Year Three as well and have noted similar progress.

Teacher Leadership Academies and On-Site Academies

Each project year's Teacher Leadership Academies (TLAs) begin at the close of the project year, in the summer months. Follow-up sessions begin in the following project year as the school year begins. As a result, this Year Three report includes findings from the Year Two TLAs and follow-up sessions held during the 2005-06 school year. The Year Three TLAs will begin during the summer 2006 months following the publication of this report and continue during the Year Four, 2006-07 school year.

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 five 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 are expected to implement a set curriculum of on-site academies for teachers in their schools/districts totaling 24 hours annually.

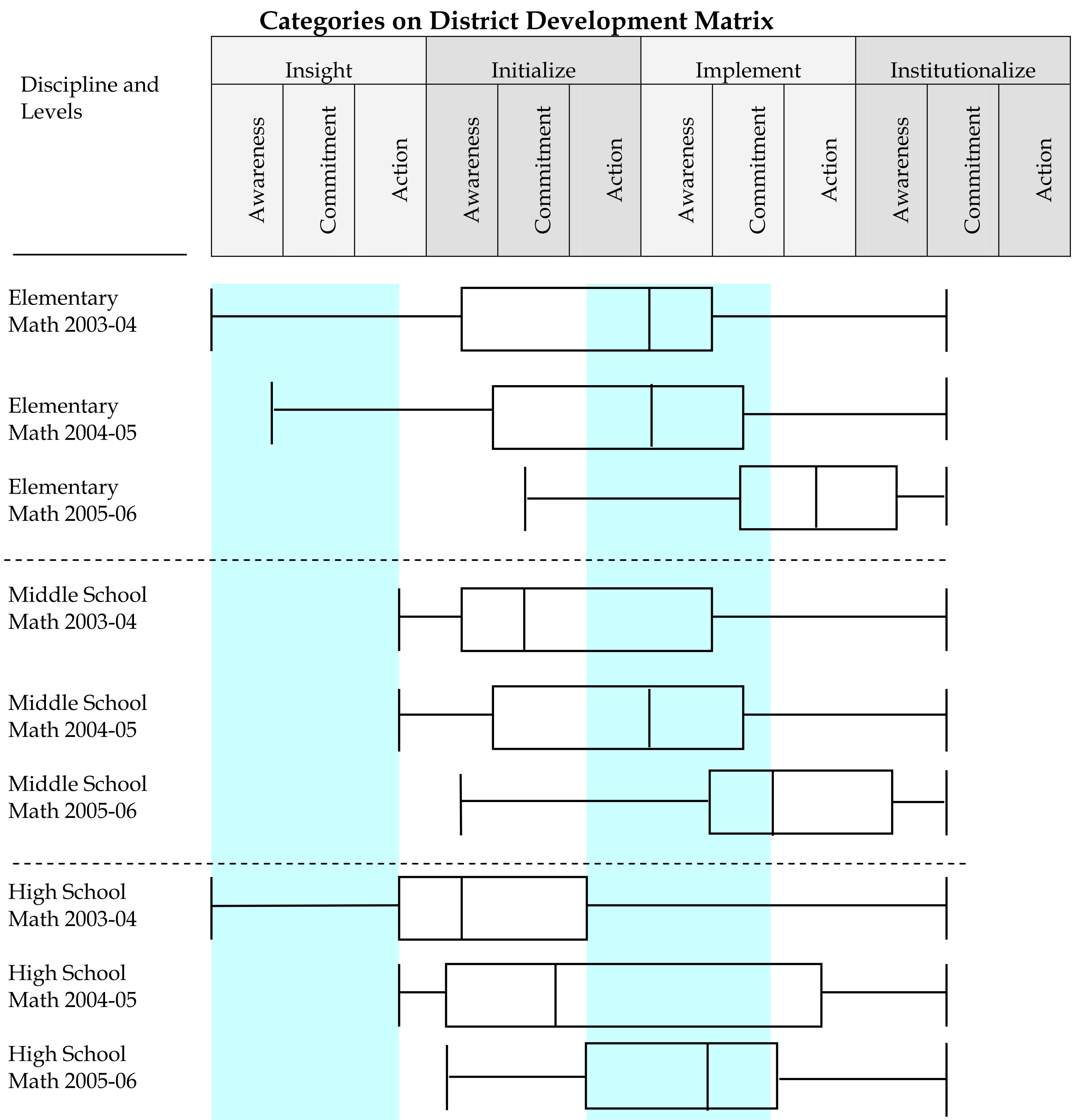

Figure 3-1: Comparison of Leadership Action Teams' mathematics placement of their districts on the Development Matrix from Fall 2003 – 2006. Each box and whisker plot displays the range of placements across MSP districts: the central vertical line shows the median, the box encompasses the second and third quartiles, and lines show the full range.

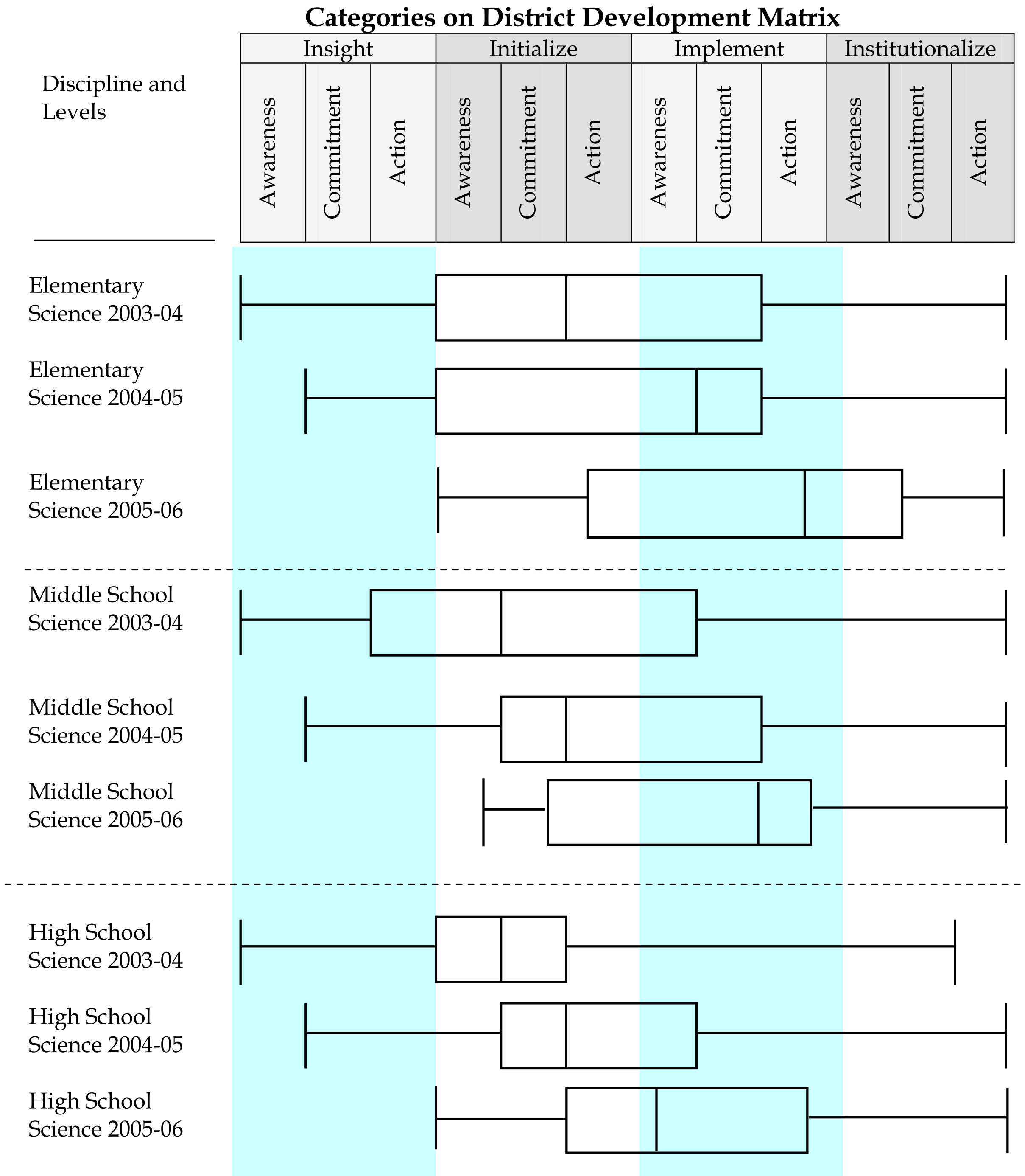

Figure 3-2: Comparison of Leadership Action Teams' science placement of their districts on the Development Matrix from Fall 2003 – 2006. Each box and whisker plot displays the range of placements across MSP districts: the central vertical line shows the median, the box encompasses the second and third quartiles, and lines show the full range.

Description of Year 3 Progress

TLAs (Year Two and follow-up) were completed for elementary and secondary math and science, involving a total of 201 teacher leaders, representing 38 of 40 NSF MSP districts.[20] The higher education partners sponsored the TLAs on their campuses and provided opportunities for involvement by math, science, and education faculty. The partner IUs hosted school-year follow-up sessions of the TLAs.

The teacher leaders and MSP staff agreed to decrease the number of days for the third and subsequent years of the TLAs as part of the overall plan to move toward a self-sustainable model. Additionally, the MSP offered a second cohort of the earlier TLAs to meet the districts that were slow to appoint and send teams to the first round of TLAs. Some changes in school administration as the project progressed created opportunities for increased "buy in" and participation.

Participant Reactions

Participants and presenters/facilitators evaluated each academy to refine processes in subsequent academies. 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 some scheduling issues in implementing the on-site workshops. Although districts had committed to 24 hours of professional development for their teachers via the on-site academies, competing priorities often prevented the actual scheduling of this much time or forced them to reduce the content of the professional development. These issues remain challenges in a few case study districts.

The MSP staff responded to these challenges by monitoring implementation through the MSP Coordinators and by setting up intervention and support strategies, as required. The PI and the K-12 project director met with central office staff and principals in several districts to help resolve scheduling conflicts and misunderstandings about intent and implementation. Additionally, MSP Coordinators made site visits to schools as a follow-up to the TLAs, offering specific feedback to teacher leaders.

Responses to summer and follow-up TLA s 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. Participant feedback in both content areas indicates that a number of participants found the materials and sessions very useful. Those involved in the Elementary Mathematics Teacher Leadership Academy and Secondary Mathematics Teacher Leadership Academy found the Concerns Based Adoption Model (CBAM) materials, as well as the corresponding ideas and support, very useful and beneficial, and concluded that they were given the opportunity to think about

[20] An additional 67 teachers from PDE districts and other districts also attended.

their own reactions to change, and of the effort they are putting into this process with respect to the effort they expect from their fellow teachers.

Participants indicated that they feel better prepared to help students develop a conceptual understanding of mathematics. The majority of participant comments reflected an enhanced understanding of student thinking through research-based tools and curriculum-appropriate activities. Participants further expressed how much they enjoyed seeing the different ways their colleagues approached follow-up session activities, and concluded that the tasks not only help them think about student learning, but about their own learning as well. Further, participants in the High School Science Teacher Leadership Academy said that the activities helped them understand better how science teaching and learning at the secondary level can be strengthened in their respective districts. Participants credited several aspects of the TLAs as being most beneficial, including the Tuning Protocol, Formative Classroom Assessment, and the Analyzing Instructional Materials (AIM) Process.

Specifically, both the original and add-on TLA cohorts agreed that collaboration is valuable. In particular, meeting and interacting with others in the professional learning community who are new to inquiry helped them to develop the comfort level needed to discuss curriculum reform, and reinforced the realization that institutional and individual change is important and necessary. They noted the demonstration of the Tuning Protocol was a useful tool for their staff in order to facilitate it within their districts. Further, Formative Classroom Assessment gave participants a better understanding of how to motivate students as well as discover how it can inform the process of attaining overarching concepts. AIM was attributed with helping participants to look at student work and assessment in order to gain a new perspective of what is happening in the classroom.

Many participants mentioned having acquired a tremendous amount of information related to content-embedded pedagogy, along with an increased awareness of how well they understand inquiry relative to other teachers, and their place in the district with respect to curriculum reform. A Vice Principal at one of the high-implementing case study schools commented that: "Teachers are trained to be in-house district experts, thereby sending a message to them and their colleagues that they are 'trusted'... this has played a big part in getting our teachers to be seen as leaders in the district—-they sit on our Leadership Action Team, they attend Leadership Action Academies and the Teacher Leader Academies. They help train other teachers. They are seen as a resource."

Many of the IHE faculty spoke favorably of the TLAs. They looked forward to continued participation and hoped for greater responsibility in the upcoming academies. Having received training in Year One and worked closely with MSP Coordinators to facilitate the academies in Year Two, some of the faculty were now involved in planning the academies for the upcoming summer (summer of Year Three). This represents an important transition from Year Two, in which many faculty reported dissatisfaction with planning because they were asked to respond to a pre-determined needs agenda rather than invited to help set the agenda and decide how to meet the needs. Participating faculty also seemed much more comfortable with the structure of the planned Year Three TLAs, reporting that planning activities have been structured more flexibly to help faculty participate.

The pedagogical impact of the TLAs was another important component that contributed to faculty's overall satisfaction with the TLAs. Many faculty were able to describe changes in their own classroom practice as a result of participating in the TLAs. For example, faculty stated that they were more aware of different ways of thinking about and approaching problem-solving strategies and were more comfortable using questioning techniques as a method of facilitating understanding.

All faculty felt that the TLAs could be sustained, but perhaps not in its current configuration due to the expense of teacher stipends. Many were pleased with the opportunity to interact with K-12 teachers, but were concerned about expenses related to maintaining the TLAs. Currently, teacher leaders receive support to attend the TLAs and there is also money for substitute teachers to cover the classes of teachers attending the TLA Follow-up Sessions. It is not clear that the universities will be able to provide this type of financial support after the funding period of the MSP has ended.

Ongoing Issues

MSP Coordinators continue to share strategies with teacher leaders to assist them in resolving differences they experience. Yet, despite best efforts, some districts have been unable to provide 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 MSP activities. During Year Three, a change in leadership in one of the districts resulted in more active participation by teacher leaders. However, it is too early to tell if these efforts will create the critical mass necessary to move to fuller implementation. The other district has been offered alternative professional development assistance to augment its own efforts with the intent of the MSP. Both of these cases are interesting examples for further study. They continue as case study districts in Year Four and are expected to be followed in Year Five so that we might better understand the challenges these districts face and how they address and resolve them.

District case study findings indicate that low-implementing 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 unable to meet the requirements for reform because of limited capacity as well as competing reforms that diffuse the focus on the MSP. The result is often unfocused activity that can create chaos in an already stressed environment. The added pressure of high-stakes accountability (including threatened and actual state takeovers) and public scrutiny by stakeholder groups can make focused and sustainable reform particularly difficult. Among the case study districts, those that fall into the "challenged" category have all reported difficulties in implementing reforms through the MSP. Case study data indicate this is most often due to competing reform models and interventions in other academic subjects, political conflicts within districts, and a lack of "buy in" from key administrators.

Among the high-implementing case study districts, participation at TLAs in the summer has remained high, although it appears from early data that there has been a slight decrease in participation during school-year follow-up sessions, *to date*.[21] The decreased participation is more evident for secondary science follow-up sessions than in either elementary or secondary math. Participation data across all MSP districts reflect a similar trend for science and, to a lesser degree, mathematics. One possible explanation arose in case study interviews, where some secondary math teachers and teacher leaders expressed doubts about the usefulness of some specific case lessons that were reviewed during their follow-up sessions. Most likely, variability in attendance by district context results from a variety of issues.

For some districts, participation at the TLAs continues to be a challenge. Three of the case study districts do not participate at the TLAs; there was also only minimal participation by one of these districts in Lenses on Learning (LoL). However, trends in two of these districts are worth noting. One district with no participation in the MSP in the 2004-05 school year has seen an increase in attendance of MSP activities in the 2005-06 school year. Prior to this change, the central leadership responsibilities in the district shifted. As a result, this district has been able to appoint one teacher leader to each of the Elementary and Secondary Math TLAs and two teachers to the High School Science TLA. These teacher leaders have had near-perfect attendance at Teacher Leader follow-up sessions. Likewise, they have had full attendance at the Everyday Math, Connected Math and Math Coaches Educator Networks, and have also attended some Leadership Action Academies and Lenses on Learning.

Another of these districts has increased its participation rates in the 2005-06 school year. The district had no participation in any of the Teacher Leader Academies in 2004-05; however, this year, it has consistently sent representatives to the High School Science Teacher Leader follow-ups. This district has had turnover in principals, and more recently, a new Superintendent. Its LAT lacks a lead administrator. The teachers on the team have stayed involved through their own initiative. Science teachers are the most active team members, which might account for their participation at the High School Science TLAs, specifically.

The experience of these districts highlights the importance of school and district leadership in how reform initiatives are perceived and implemented. However, in both previously low-implementing districts, teacher support and willingness for involvement were already established and strong. Therefore, leadership and teacher enthusiasm appear to be mutually supportive; both are necessary for creating conditions for implementing reforms.

Content Deepening Seminars

Similar to the schedule of the TLAs, a project year's Content Deepening Seminars (CDSs) begin at the close of a project year, in the summer months. As a result, this Year Three Evaluation Report discusses

[21] It is important to note that TLA follow-up sessions are continuing and registrations are ongoing as this report goes to press. While lower at this point, there seems to be an increasing number of registrations expected for the upcoming sessions.

findings from the Year Two CDSs. The Year Three CDSs will begin during the summer 2006 months following the publication of this report.

To augment the efforts of the on-site academies and to support content and pedagogical learning 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 that is needed in their districts and which teachers from their districts can best benefit by attending Content Deepening Seminars (CDSs). The CDSs 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.

As they did last year, IHE faculty recognized the value of the CDSs for establishing and extending their partnerships with K-12 teachers. However, many expressed dissatisfaction with aspects of the Year Two CDSs. In particular, they viewed the seminars as poorly organized and lacking in clear purpose and consistent guidance. These shortcomings were perceived as undermining the overall effectiveness of this MSP activity. The ambiguity about purpose centered on whether the seminars should focus on content knowledge, provide K-12 teachers with a set of materials to take back to their classrooms, or offer opportunities for hands-on activities. This focus was unclear both to faculty and teachers.

Marketing the Year Two CDSs to K-12 teachers was another issue that faculty mentioned as a weakness. Some faculty said that the seminars were not marketed well, accounting for low attendance rates and courses being cancelled due to low enrollment. In many cases, the CDSs suffered from too many options. Despite these issues, all of the faculty interviewed were enthusiastic about the sustainability of the CDSs. Faculty felt that the CDSs offered them the opportunity to teach outside the university and to think about and learn something new. Moreover, because the CDSs are based on teacher needs, the seminar offerings were plentiful and varied. For some faculty, this variety meant that the CDSs were more sustainable than the TLAs, which seemed more repetitive. Additionally, some faculty felt that participation in the CDSs was more consistent with their IHE's vision of scholarly activity and could be a factor in career advancement.

Participation rates for teachers in the CDSs were relatively low. Of the nearly 700 available slots, only 178 teachers registered and of those only 137 from 29 districts actually attended. One explanation for this may be fatigue from other professional development activities. The 2004-05 school year also marked the end of a three-year cycle professional development required of teachers by PDE. As a result, many educators had been through many professional development sessions and may have already met their quota. Thus they may have lost enthusiasm for engaging in further professional development that would essentially "not count" toward the PDE requirement.

In Year Three, the IHE leadership team met with the math and science teams jointly to work through planning and marketing issues related to the CDSs. These sessions helped to clarify the role of each team and member in producing and implementing CDSs and identified a variety of ways to notify potential participants. IHE faculty noted a number of factors that are likely to make MSP activities, including the

CDSs, more appealing to their colleagues. These included: clear goals, immediate and recognizable impact, flexibility for IHE involvement, solid marketing to a broad audience of teachers, and adequate remuneration. Enrollment in the Year Three CDSs is currently at 36; however, it is still early in the registration process for these summer offerings.

Principal Seminars – Lenses on Learning

When administrators and teachers talk about how children make sense of mathematical ideas, administrators need to bring depth and substance to the conversation. Therefore, it is important for administrators to have sufficient content knowledge about mathematics and be able to recognize math learning. The Educational Development Center, Inc.'s *Lenses on Learning (LoL)* 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 taught to rethink the observation-conference process, focusing on:

- Student understanding of the mathematical content.
- Teacher understanding of the mathematical content.
- Student learning in the current class.
- The teacher's pedagogical practices.
- The nature of the classroom intellectual community.
- The teacher's involvement in intellectual community outside of the classroom.

Four partner IUs in the region have offered LoL sessions. Participants in Year Three included 23 educators from 16 NSF MSP school districts, 13 educators from three PDE MSP districts, and 23 educators from seven non-MSP districts in the region.[22] IHE partners also participated, with five faculty members from three of the partner IHEs attending. The MSP-developed follow-up module for science pedagogy, addressing the specific needs of adequate supervision and support of high-quality science education, has also had continued participation. In Year Three, 22 educators from 14 MSP districts have participated in the science training, with an additional six from four PDE MSP districts, and one from a non-MSP district in the region.

Feedback from LoL participants indicates that this MSP activity has been a particularly meaningful experience. The majority of participants reported that it provided them with a better understanding of inquiry and a guide for observation. Some participants indicated that LoL helped them to have a more constructive focus during teacher observations. Participants also report that the add-on science module

[22] An additional 48 administrators participated in Year One and 106 K-12 and IHE educators participated in Year Two.

strengthened their understanding of teaching science through inquiry and the impact of this approach on learning, particularly when applying LoL's observation tools.

When asked to suggest topics for future sessions, participants asked for more information on how to integrate LoL with their common practice, more guidance on post-observation methods, and more information on engaging secondary teachers and administrators. Other requests included additional ideas for providing staff development using a Lenses on Learning model, audience engagement in practical examples, and incorporating data and content areas into the observation method.

Participant feedback has led the MSP to identify LoL seminars as a crucial component of participation. This led to LoL's status as a required "on-ramp" activity for districts requesting inclusion in the MSP during the planned expansion in Year Four (described in Chapter 2).

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 reform pedagogy as well as improve curricular content as fundamental precursors to growth in 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

As noted in Chapter 2, the Math Science Collaborative, which preceded the MSP, in conjunction with AIU, developed and disseminated the Math Curriculum Framework. The framework aligns the "big ideas" in mathematics with National Council of Teachers of Mathematics (NCTM) standards, the Trends in International Math and Science Study (TIMSS) international benchmarks and standards, and the Pennsylvania Department of Education standards. The Science Curriculum Framework was then developed as one of the first MSP activities, based on similar source materials. The frameworks, along with secondary analyses of state achievement test data, the two TIMSS studies, and the region's own data as a participating jurisdiction in the TIMSS 1999 Benchmarking Study, provide a basis for both diagnosing curriculum deficiencies and challenges and for developing a more focused and coherent approach to math and science education for districts across the region.

As the project progresses the focus has shifted to applying the frameworks within MSP strategies and activities, such as the TLAs, on-site academies, and LoL. MSP staff report that the frameworks continue to serve as useful resources and tools for aligning curricula. PDE recently developed math assessment anchors to help align curriculum, instruction, and assessment practices, so the Math Framework was refined last year to include these anchors. Additionally, the Science Framework includes grade-level expectations, which have been a resource to 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 shifting of emphasis across resources, strategies, and activities as the project matures. This evolution is, most likely, 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 on-site experiences at one of the partner IHEs. The intent of the TF program is two-fold: to build bridges for relationships between institutions that will benefit both K-12 and IHEs, and to serve as a form of professional development for the TF. The TFs refine and revise IHE courses, and also enroll in IHE courses to deepen their own math or science content knowledge. During Year Three, fourteen teachers participated in this program, one is spending a full year at the IHEs, and thirteen are spending one semester.

Interviews with TFs, as well as IHE faculty, indicate that the program is viewed quite positively. A number of IHE faculty indicated that working with the TFs has resulted in revised courses as well as changes to the faculty members' own pedagogy. Faculty responsible for pre-service teacher training benefited by having their course content aligned with Pennsylvania standards. STEM faculty indicated input from the TFs has given them a better sense of what incoming freshmen should know and be able to do as a result of their secondary education. For the most part, the matches between fellows and faculty were good, but this seems to have happened more by chance than strategic planning.

Most TFs indicated that the experience exceeded their expectations. Some who participated for one semester reported they would have signed up for a full-year term if they were to do it over again. They reporting having initial reservations about participating, such as concerns about finances, retirement benefits, or travel distances to the IHE sites. Several reported that they selected a fall or spring timeframe because they value their time off during the summer. The TFs said the program was not very structured, which was beneficial to their experience. However, they suggested that advance information about what to expect would have been helpful. The project might be able to address this by asking some former TFs to prepare information about their experiences to share with prospective TFs.

Dissemination and Support for the Use 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 several avenues for dissemination: Network Connections, Educator Networks and specific publications. Each is described below.

Network Connections

The semi-annual, day long Network Connections meetings involve appointed representatives from school districts throughout the 11-county Southwest Pennsylvania region and 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. 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. In the afternoon session, participants gather together in school district teams to discuss issues of importance, such as planning for professional development, as well as to share 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 Three were well received by participants and attendance was high across the region and among MSP districts. Post-session evaluation forms indicated very high ratings across all sessions and meeting components. A large majority of attendees reported that their experience with Network Connections and INTERACT better enabled them to plan next steps for their districts to address identified strengths and weakness in math or science. Overall, participants provided a rich variety of comments and specific examples of skills or experiences that they would take back to their districts, and offered suggestions for future Network Connections. Many participants rated highly the organization, facility, and schedule of the meeting. The individual sessions were well received and recommended for continued inclusion, with a particular emphasis on the high quality and relevance of one of the keynote speakers. Comments continue to indicate that INTERACT is a valuable tool for planning and sharing ideas and resources across districts. These sharing sessions continue to be meaningful for the participants by providing opportunities to connect their experiences at Network Connections with their work in schools.

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 participation status. This year, 142 educators from 27 MSP districts participated, along with 52 educators from five PDE MSP districts and 60 educators from non-MSP districts.

Participant feedback and planning data indicated that 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. The majority of participants reported that the Educator Networks helped them to extend their thinking and interpretation in order to accommodate student learning. They expressed a desire to adapt their teaching styles by incorporating content deepening as well as inquiry- and discovery-based learning in order to increase and expand student thinking. In an effort to enhance student understanding, a few participants indicated their plan to set higher expectations for students, while also accommodating different student thinking styles. Moreover, many concluded that they anticipate using what they have learned at the Networks to modify and improve their own assessment and teaching techniques while exploring new and different instructional strategies. Participants attributed these positive outcomes with active and supportive learning environments as well as the applicable student activities that were provided. They said these activities help them to think differently about teaching concepts and inquiry-based instructional strategies. Suggestions for future Network meetings included: that more consideration should be given to the mixed competency level of individuals implementing these programs, more program related topics should be covered, a greater variety of program-specific lesson materials should be provided, more information should be supplied regarding parental involvement in education, more time should be devoted to grade level discussions and assessment, and work with the "big ideas" identified in the Curriculum Frameworks should be continued.

Journal and Coordi-net Publications

Another strategy first used by the MSC and now adopted 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 CDSs 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 Three activities included the normal production and distribution of these publications along with use of the *Journal* at various meetings as a reference tool.

Summary

The MSP uses a variety of professional development and communication tools to impact science and math education among the participant districts, and beyond, through the larger scope of the Math Science

Collaborative and the intermediate unit (IU) structure of which it is a part. Year Three activities continued to represent active implementation of the program and to produce a number of outputs as intended.

Our data indicate that the TLAs continue to show improvement. However, the TLAs raise an important implementation issue: how teacher leaders will adapt the material for use in their on-site academies. Due to time constraints, varying participation rates, and limited resources—teacher leaders often had to make decisions on how to modify these school-based academies to adjust to the prevailing conditions. These adjustments raise questions about the degree to which these on-site academies can be modified without losing the original intent and integrity. Because the on-site academies are a critical element to the development of communities of learners, the evaluation team will continue to monitor, through our case study districts, the types of modifications that are being made to the on-site academies, the conditions that create them, and the impact of the changes.

The CDSs, though well received, continue to face challenges with regards to overall marketing and participation by K-12 teachers. CDSs were not well attended across the entire project. One reason for this may be that teachers were at the end of a professional development credit cycle. Most teachers had accumulated the needed credits and the incentives for participation were low. Finding ways to encourage teachers to sign up for these IHE led seminars, rather than other seminars sponsored by other organizations (e.g. science museums, for profit teaching organizations, etc.), continues to present challenges for the MSP. This year the MSP initiated a number of efforts to increase participation in the IHE-led CDSs, and it will be interesting to see if they are successful in increasing attendance. The IHE faculty continue to try to identify unique ways to market and highlight the benefits of the CDSs to the K-12 community.

Finally, the TF program continues to be a crucial link between K-12 school districts and IHEs. Fellows who participated for a semester said that if given the opportunity again, they would opt for the year-long fellowship. However, factors such as being out of touch with their students, not really knowing what to expect from the experience, and concern over benefits had been important considerations when they made their initial decisions. Finding ways to address these concerns before TFs commit to the duration of their fellowships may increase the likelihood that teachers will participate for a full year and gain the maximum benefit from the experience.

4. Institutional Practices and Support Structures

This chapter addresses the evaluation's second research question: Have institutional practices and support structures changed in K-12 districts and IHEs participating in the MSP? If so, how?

The Year Two report examined the effects of existing institutional practices and support structures on partnership building, particularly those related to: incentives and reward structures; promotion and tenure of IHE faculty; workload and time constraints; and administrative support. This third-year report re-examines the changes in institutional practices and support structures by asking, "What are some of the expected changes? And which measures can be used to assess the MSP's role in effecting these changes?"

The current version of the logic model provides some guidance for addressing these questions. The short-term outcomes in the logic model describe changes in attitudes and knowledge among leadership personnel as a result of MSP activities; mid-term outcomes in the model describe the changes in behavior, policy, or implementation of practices that should occur as a result of MSP activities; and long-term outcomes describe the project goals, i.e., increases in student knowledge, improved quality of the education workforce, and sustainable coordination of partnerships. Some of these changes are expected to occur on the institutional level, such as the changes in IHE, district, and school level policies and practices, whereas others are expected to occur at the classroom or individual level, such as changes in classroom practices. In this chapter, we examine data related to institutional level mid-term and long-term outcomes and discuss their implications for understanding how the MSP is expected to contribute to or catalyze these changes. Chapter 5 discusses changes in classroom practices.

Research question 2 focuses on both the actual changes in institutional practices and the structures that support these changes. The outputs described in logic model – the individuals, the materials, and the interactions – comprise the elements that facilitate and support the changes necessary to achieve the MSP goals. The individuals who participate in professional development for content and leadership are hopefully transformed into instructional leaders, providing both the vision for change and the means by which change can be achieved. The curricular and planning materials used in K-12 districts and IHEs must also reflect and support the goals of the MSP. The curriculum frameworks and the district action plans provide both direction and substance for improved student knowledge in math and science. Inquiry–based materials and refined IHE courses support institutional practices for conceptual learning. Finally, the interactions within and among schools, districts, IUs and IHEs that support the development of partnerships are a critical component.

Most of the analysis in this chapter is based on data from case studies of K-12 districts, interviews with MSP staff, and interviews with IHE faculty and teacher fellows. We have also included information from the baseline teacher and principal surveys where appropriate. Follow up surveys, planned for Year Four, will enable the evaluation to track changes to institutional practices and structures.

Changes in Institutional Practices

In this section, we focus on outcomes from the logic model that reflect changes in practices at the institutional level: administrative leadership, district policies, the use of data in decision making, and the alignment of curriculum with state standards. Other key mid-term outcomes will be discussed in the following section *Changes in Support Structure* as well as in Chapter 5.

Improved Administrative Leadership

Principals can play a major role in setting the tone in a district, in determining district practices, and in developing and maintaining support structures for teachers who are interested in reform. These leadership skills are evident in some case study districts. For instance, many case study districts reported a strategic move when they organized their Leadership Action Teams and chose their Teacher Leaders. Personnel were chosen based on their behaviors and positions in the district, whether it was because they were the department chair, or happened to be the person that was a "doer" in the building. Two of the LAT lead administrators reported that the district devoted a great deal of time and thought to how, when and where the on-site academies would be scheduled. The MSP staff, including the PI and MSP Coordinators, recognizes that district leadership is one of the key factors in how well the MSP activities are implemented in the districts, and report that the LoL seminars are very useful in bringing district administrators on board. As mentioned earlier, the project has recognized this as an important factor in success of the leadership teams and has thus made participation by a district administrator in the LoL seminars a prerequisite to becoming an expansion district.

The principal survey covers some leadership issues of interest here, including content knowledge and knowledge of standards and curriculum. Generally, principals reported a high level of content knowledge in math and science: 63% for math, 59% for science. Forty-nine percent reported high content knowledge in both subjects. Conversely, 27% reported high content knowledge in neither subject. In addition, principals *agreed* that they are knowledgeable about current national standards in math and science and the math/science curriculum in their district, and that they feel well prepared to support teachers in implementing the curriculum (Figure 4-1).[23]

[23] Figure 4-1 depicts the factor score for the scale: Principal knowledge of math/science curriculum and standard, and preparedness to support teachers. The circle represents the mean value and the distance the "tails" extend from the circle represents the standard deviation.

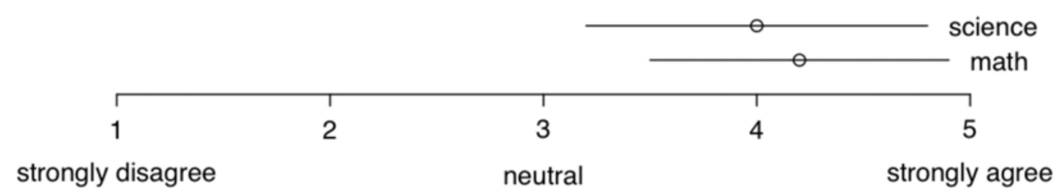

Figure 4-1: Principals reported that they are knowledgeable about current national standards in math and science and the math/science curriculum in their district, and that they feel well prepared to support teachers in implementing the curriculum. The rating for science is significantly lower than the rating for math (p<0.001).

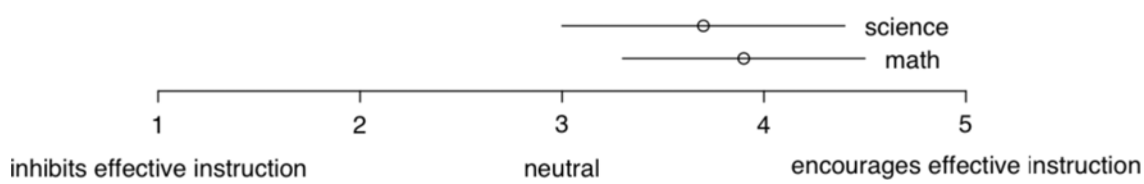

Figure 4-2: Principals rate the effect of district and school policies and reward structures on effective math and science instruction. The rating for science is significantly lower than the rating for math (p<0.001).

Changes in District and School Level Policies and Practices

Successful implementation of the MSP project may require, or lead to, some changes in district, school, or IHE level policies and practices. However, in many cases it takes time to create change in these institutions. One example of a required change in K-12 is in the implementation of the on-site academies. Many districts are unaccustomed to devoting so much time to professional development, let alone a single professional development program. If insufficient time is available to meet the MSP's call for 24 hours of on-site academies, additional costs may be incurred to free teachers' time to attend. One district reported that it had to secure additional funding to do this.

The principal survey addresses some of the district level policies that might change as a result of the MSP, including curriculum, assessment, professional development, and academic standards. Principals rated the effect of district and school policies and reward structures on effective math and science instruction from *neutral* to *encourages effective instruction* (see Figure 4-2). This scale score includes policies such as adoption of a regional curriculum framework, district and school level testing policies and practices, and district and school structures for recognizing and rewarding teachers. Principals reported they have *some influence* on policies regarding professional days, including professional days built in before the beginning of the school year, during the school year, or after the school year. Only 25 percent of principals reported they control a budget for professional development in their school. Principals *agreed* that their district supports school improvement, through activities such as fostering communication between different schools in the district, supporting schools in meeting district mandates, and encouraging principals to take risks in order to make changes.

Our interview data indicated that at the partner IHEs, the Deans' Dinners have facilitated discussions across the institutions, including discussions about policies. In addition, on each IHE campus, discussions are taking place about the sustainability of various MSP activities.

Use of Data in Decision Making

The MSP encourages districts to analyze their data and use that data in developing district plans. Interviews with key personnel at three case study districts indicate that the data gathering and analysis that occurred during the LATs, including the SWOT analysis, have influenced decision making. As an example, the administrator on one district LAT reported that the district has begun to refocus on students' needs based on what data are telling them rather than on "teaching to the PSSA's." This administrator believed that by focusing on the students, the PSSA's will "take care of themselves." In another case study district, analysis of TIMSS data along with PSSA data helped the district with course refinement.

Baseline data from the principal survey indicate that principals conducted data driven decision making activities more than once a month. Such activities included working with teachers to develop and share interim measures of student learning, discussing student achievement data with teachers, and using a well-designed incentive system to reward teachers for progress toward school-wide goals.

Alignment of Curriculum with Professional Development and State Standards/Implementation of Challenging Courses

Quality teaching depends in part on a rigorous curriculum, reliable assessments, and instructional materials aligned to standards. Each of these is an example of a support structure that can affect teaching. The MSP project addresses these issues in multiple ways, including developing and distributing the curriculum frameworks, delivering content through the TLAs and content deepening seminars, and conducting activities for the teacher fellows on IHE campuses. These activities are producing some positive results.

From the baseline survey, teachers, in discussing professional development they have participated in, reported that professional development has had only slight to moderate emphasis on assessment data, standards, and curriculum (Figure 4-3). This emphasis includes, for example, alignment of math/science instruction with the curriculum, state content standards, and state assessments. However, the case studies revealed examples of teachers using the standards as a result of MSP involvement. One high school science teacher noted that teachers "are now required to have lesson plans with objectives and aligned standards." She equated this with their district's more focused look at its PSSA results and its involvement in the MSP. For some of the case study districts, Year Three of the project brought an opportunity to engage in curriculum mapping and to begin the process of aligning the curriculum to state standards. Two case study districts noted that this process has enabled them to find the "gaps and overlaps" in their lessons. It has also enabled them to have coherency across grade levels and between buildings.

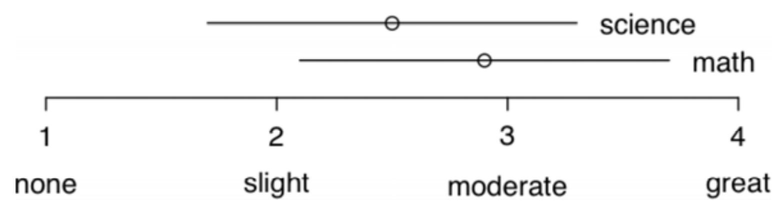

Figure 4-3: On the baseline survey, teachers rated the professional development that they have received in terms of whether there is an emphasis on assessment data, standards, and curriculum. The rating for science is significantly lower than the rating for math ($p<0.001$).

The districts also noted some obstacles to providing a rigorous curriculum, including a lack of preparation and planning time to implement these research-based instructional materials. High school science teachers from three of the case study districts highlighted their struggle to work around a lack of planning time and their class schedules. These districts are working within the constraints of 42-minute class periods which, the teachers noted, "do not allow them the ability to have rigorous labs." Four or five teachers share a lab in one district. Interviews with high school science teachers at one district suggested that "administration take a look at their own policies and practices," which prohibits curriculum reform in the science department. These teachers said more emphasis is currently placed on ensuring math reform than science. One high school science teacher observed that some teachers had experience with inquiry-based instruction from college but that the current class scheduling and lack of common planning time "excludes them from carrying out these types of lessons" and does not enable them to provide professional development to their colleagues to support this curriculum initiative. In contrast to this case, another district has used a block schedule to implement better inquiry-based labs.

At the IHE level, faculty have more knowledge of the state standards as a result of working with teacher fellows, who help the faculty revise their courses. While faculty were very positive about their interactions with teacher fellows in general, some questioned the importance of aligning their courses with the state standards or identifying where state standards were met in their courses. However, as mentioned in Chapter 3, some faculty did report that this made them more aware of what to expect from incoming students.

Changes in Support Structures

Clearly, changes at the institutional level are important in order for the MSP to achieve its goals. Formal policies and practices provide the framework to enable individuals participate in and benefit from MSP activities. However, other less formal types of support are also necessary and can be viewed as the "glue" that holds together and maintains the larger framework. In this section, we discuss the development of some of the informal support structures that are no less important than the institutional ones. These support structures are the development of partnerships, which depends on individual interactions rather than institutional interactions, and the creation of professional learning communities.

Development of Partnerships

Partnerships take time to fully develop. Interviews with IHE faculty, MSP project staff, and case study data indicate that the partnerships developed through the MSP are continuing to evolve. The MSP offers opportunities for many different types of partnerships: IHE faculty in different disciplines, faculty at different IHEs, IHE faculty and K-12 teachers in school districts, faculty and MSP or IU staff, or between and within K-12 districts and IUs. These partnerships constitute support structures that strengthen the MSP infrastructure. The Year Two evaluation report focused on these emerging partnerships as a precursor to changes within individual institutions, and it noted progress on many fronts. This year, within and across the IHEs, we observed that these partnerships continue to grow. However, types of partnerships that are facilitated by individual relationships are still somewhat limited.

Many faculty reported more interactions on their campuses between math, science and education faculty. Although some of these interactions existed prior to the MSP, the MSP activities facilitated and strengthened these interactions. However the opportunity for partnership building between education and math and science faculty has been somewhat limited because of the small numbers of education faculty involved in the MSP who teach math and science education. Typically, only one or two members of an education department work with math and science teachers on methods courses. An example of the increased partnership within an IHE was collaboration between math, and science and education faculty on a recent successful grant proposal.

Across the IHEs, faculty reported an increase in interactions with partner IHE faculty, but these interactions have not yet fostered collaborative relationships. Some faculty expressed frustration with missed opportunities to interact. For example, at Network Connections, opportunities to interact were missed because faculty had been seated with others from their own institutions, rather than with faculty from other IHEs. Interviews with IHE administrators suggested that the Deans' Dinners have been useful in bringing the IHEs together and encouraging interactions. However, both faculty and deans expressed some concern about whether these types of partnerships will continue after the project concludes, since they take a fair amount of time, effort, and well-aligned incentives to maintain.

With K-12 teachers, partnership building seems to largely depend on the time IHE faculty and K-12 educators have spent working together. When faculty members were asked to give examples of partnership, they reported that TFs were the best example, followed by CDSs and TLAs. In some cases, MSP activities have led to additional involvement of K-12 teachers at the IHEs. In one case, a former TF returned to campus to deliver a guest lecture in an IHE course. At one IHE, two TLA attendees have been hired as adjunct faculty to teach night courses. Though not necessarily the types of interactions planned for by the MSP, these are examples of the connections that can be fostered by the MSP. Beyond these examples, however, most faculty reported that very little follow-up had occurred from the MSP activities, with the exception that some faculty reported seeing some of the teachers from TLAs or CDSs at Network Connections.

Faculty also discussed partnership with the MSP Coordinators. In fact, a few faculty described all of the meetings, planning sessions, and professional development trainings held at AIU as a strength of the MSP. They reported these activities developed a sense of camaraderie between IHE faculty and MSP Coordinators. However, as discussed in previous evaluation reports, these meetings still present a challenge for the MSP, in terms of time and logistics. A few faculty have become very involved with the MSP, especially in the planning for TLAs, and feel their input is valued by the MSP staff. A number of factors seemed to be critical to their increased involvement: deliberate effort on their part to regularly attend MSP meetings; recognition of the value of faculty input by MSP Coordinators; and flexible teaching schedules that allowed them to have large blocks of time open during the week (e.g. teaching only on Monday, Wednesday and Friday). On the other hand, some faculty reported that they still feel that the planning for TLAs occurs without IHE input, even if they are interested in participating. They reported not receiving advance notification about planning meetings. Whether this is a result of poor communication, either at the IHE level, or at the MSP staff level or cultural differences between IHE and K-12 is unclear. One faculty member mentioned that MSP Coordinators are often unaware that faculty would even want to be involved in the planning stages of the TLAs, suggesting that increased communication between the MSP Coordinators and IHE faculty might help to resolve some of these issues.

At the K-12 level, case study data indicate that there has been more communication across schools within a district, and even across districts. The MSP Coordinators reported that science teachers are often very interested in this type of interaction, as there are few science teachers in any given school building. In addition, there appears to be a renewed interest and participation in the Network Connections INTERACT time, even among non-MSP districts.

Communication is an important element in any partnership. In previous reports, we have noted that communication is an on-going challenge to the MSP, due to its size and the diversity of its partners. Some comments from IHE faculty in Year Three, suggested that the MSP cabinet meeting, one of the primary means of keeping all partners abreast of partnership activities, is a good vehicle for communication. Other faculty reported that the MSP cabinet tries to accomplish too much during its meetings.

Some faculty reported that they do not get enough direction on what is required for a CDS. Teacher fellows reported that they would have liked to know more about the program before arriving at their respective IHEs. The MSP continues to refine its communication strategies. In some cases, IHEs are addressing the issue of communication with K-12 teachers directly. As examples, one IHE held an event for incoming TFs this spring, and at another IHE a faculty member called each teacher who was signed up for a CDS to get their input before the summer course began.

Creation of Professional Learning Communities

The MSP interventions are designed to develop professional learning communities at the K-12 and IHE levels. These communities need support from administrators to be successful. At the K-12 level, the principal and teacher surveys capture some data on support for teachers' non-instructional time and professional development. Our interviews with IHE faculty and deans also gathered some data on this topic.

On the baseline survey, principals rated the effects of several types of supports for teachers, such as time available to plan and prepare lessons, to work with other teachers, and for professional development, as somewhat encouraging the development of a professional learning community. Principals reported having some influence on policies that allow teachers time to create professional learning communities, including policies such as providing substitute teachers to cover teachers' classes, common planning time for teachers, and reduced teacher work loads (both in the classroom with students and on assigned non-instructional duties). However, teachers reported the frequency of activities that emphasize interaction and collaboration among teachers as approximately *one to two times per year*. Such activities include participating in a teacher network or collaborative of teachers supporting professional development, participating in a committee or task force focused on curriculum and instruction, or attending conferences related to math or science education. In addition, teachers reported that professional development activities that are relevant to school and teacher needs are rare.

During IHE interviews, some faculty and deans reported that some of the major benefits of the MSP are faculty exposure to research-based practices and opportunities for the faculty to attend and present at national conferences. As discussed in the partnership development section, math, science and education faculty reported having more intellectual interactions with faculty outside of their respective disciplines. Some faculty and deans reported that strength of the MSP is the "world class" professional development that is being received by faculty members.

Toward Achievement of Project Goals

As stated in the logic model, the long-term outcomes are the project's goals. Goal 1, increased K-12 students' knowledge of mathematics and science is related to the fourth research question and is addressed in Chapter 6. The second goal, increased quality of the K-16 teacher workforce, is addressed primarily in Chapter 5. One aspect of this second goal, involving IHE students training to become teachers, is an institutional practice addressed in this chapter. Finally, many elements of the third goal, sustainable coordination of partnerships in the IUs, feedback loops between K-12 districts and IHEs, improved math and science learning experiences for all undergraduates are related to institutional practices and support structures and are therefore addressed in this section.

Increased Quality of K-16 Educator Workforce: Student Teacher Placement

One way to improve the quality of the K-12 workforce is to foster high-quality teachers graduating from partner IHEs. The project's approach to improving teacher quality involves placing student teachers from partner IHEs in MSP districts. This placement allows student teachers to be mentored by teachers who are part of the leadership cadre. During our interviews, each of the IHE team leaders and other faculty involved with the grant identified this mentoring as a crucial aspect to the long-term impact of the partnership. As one faculty member who supervises student teachers reported, if the student teacher is not placed with a mentor who appreciates the value of inquiry-based approaches, attempts by the student to implement these approaches are "shot down" with negative feedback.

The following MSP goal addresses student teachers:

> By the end of year 5, Sustained Feedback looping between K-12 and IHEs will include: 90% of the student teachers in elementary and secondary math and science, who are placed in partner districts, will be placed with members of the K-12 leadership cadre.

The leadership cadre includes the K-12 teachers on the LAT and the teacher leaders who attended the TLAs. Because of the difficulty in placing student teachers with specific leadership cadre members in school districts, the MSP has changed the goal from placing student teachers with the leadership cadre to placing student teachers with teachers involved in the district "communities of learners" when possible.[24]

This student teacher placement goal addresses one part of the placement: matching student teachers, who are placed in partner districts, with the leadership cadre. However, many of the IHE faculty have a separate, unstated goal of placing *more* of their student teachers in MSP partner districts. Both of these steps, getting more student teachers into the partner districts and getting them assigned to members of the leadership cadre, are difficult to accomplish. The process for placing student teachers can be a district process, or it can include going through a "middle-man" in some districts that are involved in consortia that manage student teacher placements. One of these consortia did not accommodate requests from the partner IHEs to place their student teachers in specific MSP districts. In addition, the student teachers themselves often have preferences for their placements that override the MSP goals.

The IHE team leaders are aware of the difficulty with student teacher placements. At the beginning of Year Three, the IHE project director wrote a letter to all the district superintendents requesting that they give priority to student teachers from the partner IHEs. In one successful placement, the IHE contacted a teacher leader directly and both the IHE and the teacher leader worked through the district to get a student placed with that teacher. We did not interview student teacher placement coordinators at the IHEs or at the school districts, but we observed that none of these coordinators at IHEs are directly

[24] As indicated in the 2005 MSP Annual Report

involved with the MSP, for example, through membership on the IHE's LAT. If the student teacher placement coordinators at the IHEs and K-12 districts had more direct roles in the MSP, the likelihood of reaching the student teacher placement goal might be improved. At a minimum, some degree of involvement would facilitate communication between the project and the student teacher coordinators about the goals and activities of the MSP.

Sustainability Coordination of Partnerships; Feedback Loops

The third goal of the project includes sustaining the partnerships in the IUs and feedback loops between K-12 districts and IHEs. The term sustainability has not been well defined across all of the MSPs, although there has been considerable discussion about it. In this case, the partners are trying to determine what "sustainable" means. In part, sustainability means fulfilling the financial agreements spelled out for the final two years of the grant. The agreement requires partners begin assuming some of the expenses of the project (one-third during Year Four and two-thirds during Year Five), a progression that would lead to full assumption of these expenses when the project concludes. Over the longer term, sustainability refers more to continuing the nature and partnerships of the MSP project.

The MSP Coordinators are a direct link between the IUs and K-12 districts, and their salaries need to be covered by the IUs if these positions are to be sustained. As noted in Chapter 3, the coordinators are spending more time at the partner IUs. In addition, in interviews the coordinators reported becoming more comfortable interacting with the lead administrators on district LATs. According to the PI and K-12 project director, each of the IUs view the role of the coordinators differently. The PI and K-12 project director continue to work with each IU to help them recognize the value of the MSP Coordinators, and the IUs are responding in unique ways to meet their financial commitments to the project. Nevertheless, the project PI reported that some coordinators are concerned about the future of their positions. Many gave up "tenured" positions at districts to join the MSP, and now they do not have as much job security.

IHE faculty and deans reported that many of the MSP activities are sustainable. However, in many cases, they anticipate that the activity will change somewhat once the IHE has more of a role in maintaining the activity. For instance, on some campuses the TLAs and CDSs might become part of a graduate program. In general, the deans at each IHE were cautious about stating a long-term financial commitment to the MSP. While all were positive about the benefits, and all cited examples of activities they would like to see continued, they recognize that they cannot allow the MSP to become a financial burden on the IHE.

Another aspect of sustainability on the IHE campuses relates to whether participation in MSP activities factors into promotion and tenure decisions. All four IHEs are relatively small, teaching-oriented colleges and universities. However, the faculty at these IHEs reported they feel increasing pressure to publish original research in peer-reviewed publications. The IHEs administration reported that participation in MSP activities is considered during promotion and tenure decisions, either as a form of teaching, as service, or as research if the a publication or presentation is produced. Faculty, however, reported that they already meet (or exceed) the requirements for promotion and tenure in terms of teaching and service, and research is the only area that they need to build. In addition, disciplinary faculty were not certain whether publishing in education journals, a logical avenue for MSP related work, would “count” as research. In one case, a faculty member raised this concern even though the dean reported that this type of publishing would count. This indicates either a lack of communication on the campus, or a level of doubt on the part of the faculty member. In many cases, the faculty who are most involved already have tenure. One tenured faculty member mentioned that they would not “allow” non-tenured faculty to get too involved with the MSP. This issue of promotion and tenure could impact how well the program and activities can be sustained at the IHE level.

Summary

Year Three of this project has brought signs of changes in institutional practices and support structures that are related to MSP activities. It is still too early to determine the full impact of these changes. Some changes are occurring at the K-12 level, including examples of district leadership, the use of data to drive decisions about students and teaching, and the alignment of curriculum with state standards. In addition, some of the desired changes are evident on the IHE campuses, such as identifying state standards in college courses and developing partnerships across the institutions.

The building of partnerships continues to evolve for this MSP. Many of the partnerships, however, consist of relationships at the individual level, which are not yet manifested at the institutional level. In addition, there is a continued need to improve communication within and among partners, as this continues to be a logistically complex and involved project.

At the IHE level, the inclusion of deans on each campus has facilitated the growth of partnerships and led to discussions around sustainability. However, each of the IHEs recognizes the financial risks associated with the MSP and, while committed to the project, also recognize that sustaining the MSP will require them to take ownership and adapt the activities to best suit their campuses.

5. Math and Science Instructional Practices

The third research evaluation question focuses on the midterm outcome of changes in instructional practices. "Have math and science instruction changed in K-12 districts participating in the MSP? If so, how?" This outcome is critical for the program because it is a precursor to achieving the long-term MSP goals of increasing K-12 students' knowledge of mathematics and science and increasing the quality of the K-16 educator workforce.

Changes in instructional practices, particularly sustainable ones, depend on many factors. The logic model highlights some important short- and mid-term outcomes that contribute to teachers' ability to engage in classroom practices that enhance K-12 students' knowledge of mathematics and science. Some of these outcomes should be evident at the classroom level, such as increased awareness and knowledge of research-based instructional practices and materials, increased teacher content knowledge, and increased principals' leadership skills, which enables them to serve as instructional leaders. Other outcomes, as discussed in Chapter 4, are targeted at the school and/or district level, including changes in policies and practices, use of data in decision making, and alignment of curriculum with professional development and state standards, all of which can contribute to and support teachers' efforts to change instructional practices.

Although it is still too early in the project to fully evaluate whether the MSP has fostered changes in instructional practices, this chapter examines some of the issues that are emerging from the case study data and discusses how these issues may influence changes in teacher instructional practices. This chapter also draws on extended analysis of teacher and principal survey data to identify baseline characteristics related to classroom instructional practices. Finally, as in the Year Two report, we note that through participation in MSP activities, IHE faculty are beginning to change their instructional practices as they become aware of research-based pedagogy. Thus, this chapter also discusses the impact of the MSP on IHE instructional practices.

Awareness and Knowledge of Research-Based Instructional Practices and Materials

In the MSP, the professional development activities are essential to ensuring that teachers not only understand *how* to change instructional practices, but also *why* such changes are important. Awareness of the larger purpose behind these changes is a critical component of sustainability as it provides teachers with a foundation that should last beyond the funding period of the MSP. The teacher survey asked teachers about the professional development activities that they participated in prior to the MSP, and specifically, which topics were emphasized. Teachers reported that the professional development activities they participated in placed only *slight* to *moderate* emphasis on topics related to student learning and student needs. These topics include: individual differences in student learning, the study of how

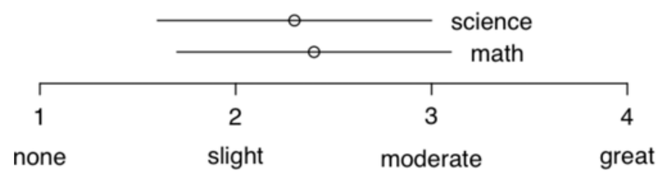

Figure 5-1: On the baseline survey, teachers rated the amount of emphasis given to topics related to student learning and student needs in their professional development activities. The difference between math and science teachers is small, but statistically significant ($p< .001$).

children learn, and varying instructional approaches. As shown in Figure 5-1, the difference between math and science teachers on this scale was small, with math teachers with the mean value for math teachers closer to *moderate* emphasis.[25] Although small, this difference was statistically significant. As noted in Chapter 4, when asked about professional development that emphasizes topics related to assessment data, standards, and curriculum, teacher responses were still in the *slight* to *moderate* range. However, the difference between math and science teachers was larger, with math teachers closer to *moderate* emphasis (see Figure 4-3).

This result may reflect the prominence of math testing relative to science, and that prior to the MSP, professional development that was aimed at changing instructional practices may have been more narrowly focused on state standards and increasing test scores, rather than a deeper understanding of how students learn. The MSP aims to have a significant impact in this area by providing professional development activities that stress student-centered aspects of learning. Studies on the effects of professional development activities have found that programs which focus on subject matter content and how students learn have the largest positive effect on student learning (Kennedy, 1998). Moreover, other studies indicate that content focused activities, such as those emphasized by the TLAs, have substantial positive effect on enhanced knowledge and skills (Garet et al., 2001).

Increasing Teacher Content Knowledge

As outlined in the MSP theory of action, increasing teacher content knowledge is important to achieving changes in teacher practices. Increased content knowledge makes teachers more comfortable with using many of the strategies advocated by the MSP. Evaluation summaries of the content deepening seminars were generally positive. The majority of participants responded that looking at the mathematics in the seminars deepened their understanding of the content quite a bit. Responses focused on the participants' better understanding of *Everyday Mathematics* and *Connected Mathematics* as a result of follow-up

[25] Similar to the figures in Chapter 4, the circle represents the mean value and the distance the "tails" extend from the circle represents the standard deviation.

implementation sessions as well. Some participants further responded that the step-by-step instruction helped them understand the content more in deeply, and helped them to verify what they are doing right and wrong. If they were not already comfortable with the content of the unit, participants considered the workshops extremely valuable, allowing them to further understand the importance of concepts that need to be covered in these particular curricula, anticipate questions and confusion that students may encounter, and provide insight into more efficient teaching strategies.

Increasing Leadership Skills

Increasing principals' capacity to serve as instructional leaders is an important goal of the MSP. Through LoL, the MSP prepares administrators and principals in particular, to support effective math and science instructional practices. Although many aspects of a principal's role can be viewed as providing institutional support to teachers (e.g., allocation of resources, policies to support the creation of learning communities, etc.), other aspects of their job (e.g., classroom observation and teacher supervision) directly support teachers in their efforts to change instructional practices. In visiting classrooms and talking with teachers, principals come into direct contact with instruction, judge its adequacy, and decide what kind of help and support a teacher may need. In this way, administrators, and principals in particular, can be considered instructional leaders serving as "arbiters of instructional quality in their schools" (Nelson, Benson, and Reed, 2004, p. 6).

The principal survey examined principals' comfort in undertaking activities that are associated with serving as an instructional leader. These activities include: discussing concrete examples of instructional practice with teachers; observing classroom instruction; and visiting classrooms and examining student work. Principals reported that they are *very comfortable* serving as instructional leaders, with principals reporting they are slightly more comfortable undertaking these activities for science than math. This high rating is rather interesting since most of the principals we surveyed had not participated in LoL or were very early in the LoL training. One explanation may be that principals feel over-confident in their abilities and that their exposure to content and supervisory techniques through LoL provides for a more realistic assessment of their competence. Additionally, only about half of the principals we surveyed reported that they have high content knowledge in both math and science. Those who rated themselves as having lower content knowledge rated lower on this scale, as well. Although it is not clear whether this is a causal relationship, it does suggest that increasing principals' content knowledge might increase their confidence with respect to instructional leadership.

In addition to asking principals about their comfort level in serving as instructional leaders, we also examined the frequency with which principals engage in activities reflective of an instructional leader. Items on this scale include: holding pre-observation conferences with teachers; visiting classrooms and examining student work; visiting classrooms and meeting with teachers to provide feedback on teaching. Principals' responses ranged from *monthly* to *weekly*. It is difficult to interpret these results since frequency with which principals *should* engage in these activities may depend on many different factors.

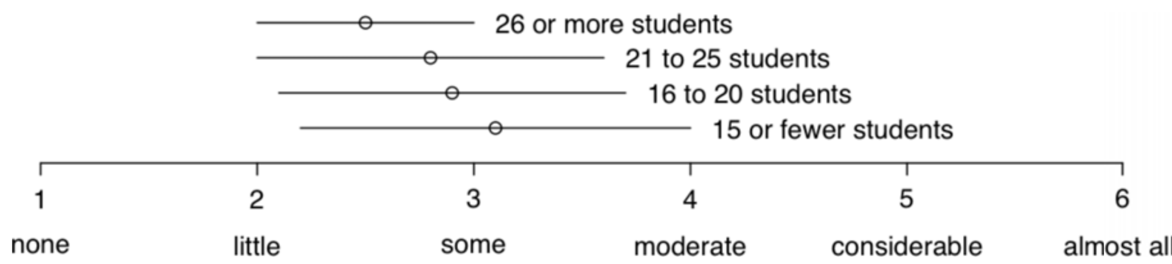

Figure 5-2: Relationship of class size to amount of instructional time spent engaged in active learning in mathematics

For example, visiting classrooms to meet with teachers and provide feedback on teaching may be appropriate on a weekly basis; on the other hand, activities such as examining student work may be more effective on a monthly basis.

Classroom Instructional Practices in Math

Through research-based curricula such as *Everyday Mathematics, Investigations,* and *Connected Mathematics,* the MSP provides teachers with materials and strategies for encouraging students to build on knowledge and conceptual understanding. In our analysis of the baseline teacher survey data, we examined teacher responses to the amount of mathematics instructional time spent engaging students in "active" learning, which includes the following activities: doing a mathematics activity with the class outside the classroom; presenting or demonstrating solutions to a math problem to the class; and working in pairs or small groups on math exercises problems, investigations or tasks. Our analysis indicated that amount of instructional time teachers engaged in active learning ranged from *little* (10% or less of classroom time) to *some* (11-25% of classroom time). These findings indicate some room for improvement. Moreover, the difference between high school and K-8 teachers on this scale was small, but significant: with K-8 teachers spending more time engaged in active learning. Our analysis also examined whether class size was related to amount of time spent in active learning. Here, we noticed an interesting trend — teachers reporting class sizes of 26 or more students spend less time engaged in active learning than teachers reporting class sizes of 15 or fewer students (Figure 5-2). The analysis of mathematical instructional practices also examined the amount of instructional time teachers engaged in other, less active types of learning, such as completing computational exercises or procedures from a textbook or worksheet, watching the teacher demonstrate how to do a procedure or solve a problem; or taking notes from lectures or textbooks. We refer to these behaviors as "passive" learning, to indicate that these activities require less hands-on activity by students. For this scale, we found that the amount of time that teachers reported engaging in these activities ranged from *som*e to *a moderate amount* (26-50% of classroom instructional time). Not surprising, high school teachers scored slightly higher on this scale than K-8 teachers.

Data collected from Year Three MSP event observations indicated that math teachers are benefiting from MSP activities focusing on the use of more active learning and are pleased with what they are learning. Moreover, all of the case study classroom observations rated elementary math classes as exhibiting *effective* to *exemplary* instruction including "active" student learning opportunities. Because the classroom observation protocol that is used to rate instructional lessons is informed by the MSP activities, this rating also indicates that instructional practices are aligned with those encouraged by the MSP.

Classroom Instructional Practices in Science

Through the science curriculum framework and the high school science TLAs, teachers are encouraged to use inquiry as the primary basis of teaching scientific materials rather than lecture alone. In our analysis of the baseline teacher survey data, we examined the amount of time teachers reported engaging in "active" learning, including: doing a science activity with the class outside of the classroom; doing a laboratory activity, investigation, or experiment; and collecting data in activities other than laboratory activities. As with math, the amount of time teachers reported engaging in "active" learning in science ranged from *little* to *some*. Also similar to math, K-8 teachers reported spending more time engaged in active learning. However, in science, the difference between K-8 and high school teachers was small (Figure 5-3).

In addition to engaging in active learning, which is based on students' engagement in hands-on, interactive activities, the MSP also advocates activities that challenge students to think like scientists. In our teacher survey scales, these activities are referred to as "scientific habits of mind" and include the following survey items: analyzing and interpreting science data; changing a variable in an experiment to test a hypothesis; and making educated guesses, predictions, or hypotheses. Compared to "active learning," all teachers ranked slightly higher on this scale, reporting that students spent *some* to *moderate* amounts of instructional time engaged in activities that demonstrate scientific habits of mind. On this scale, high school teachers were slightly higher than K-8 teachers, with more high school teachers reporting *a moderate amount* of time engaged in activities that demonstrate "scientific habits of mind."

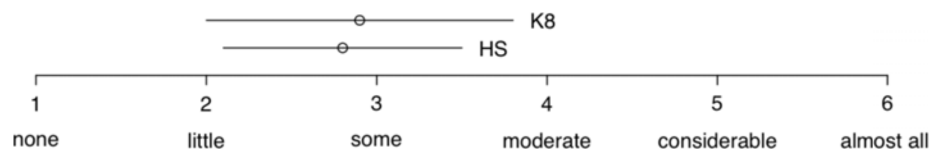

Figure 5-3: Teacher responses on the amount of instructional time spent engaged in active learning in science

Finally, in our analysis of the teacher survey, we examined the amount of instructional time spent communicating science through either verbal or written methods. Defined as "science communication," the survey items in this scale include: talking about ways to solve science problems, such as investigations; working on a writing project or entries for portfolios seeking peer comments to improve work; and writing up results or preparing a presentation from a laboratory activity, investigation, experiment, or research project. These are critical skills in science as they encourage students to articulate their thinking, providing a valuable tool for teachers to assess conceptual understanding. Teachers reported spending *little* to *some* amount of science instructional time communicating science through either verbal or written methods. On this scale, high school teachers scored higher than K-8 teachers, with more high school teachers reporting *some* instructional time spent engaged in science communication.

Some of the trends in our extended analysis of the baseline survey data may be explained by information emerging from the case studies, particularly the finding that science teachers reported spending, on average, between 10 to 25% of class time on active learning. Data collected from one of the high school science TLAs indicated that teachers found the inquiry-based activities to be the most helpful. They noted that the hands-on activities and inquiry experiments helped them to gain a better understanding of what an inquiry lesson would look like, and dispelled some of their previous misconceptions. Further, the teachers noted that there is a much wider variety of styles and activities that can be considered inquiry-based science than they realized. Also helpful was seeing a structured plan of activities and information centered on inquiry-based science as the primary teaching method, rather than the traditional lecture method. These opportunities gave them a lot of information, exposure, and insight into different approaches that can be used to reach their students. Moreover, interacting with others in the professional learning community who are also new to the inquiry approach helped participants develop the comfort level needed to discuss curriculum reform, and reinforced the realization that institutional and individual change is important and necessary. Their comments suggest that lack of awareness and understanding of inquiry-based science may be one of the reasons teachers are not spending much classroom time engaged in active learning.

However, as noted in Chapter 4, another obstacle to engaging in inquiry-based practices is inadequate preparation and planning time to implement these research-based instructional materials. High school science teachers from three case study districts mentioned the struggle that they have with a lack of planning time and with their class schedule.

IHE Instructional Practices

Through participation in MSP activities such as the TLAs, working with teacher fellows, and attending events such as Network Connections, IHE faculty have numerous opportunities to learn and reflect on the same inquiry-based and hands-on teaching practices as K-12 teachers. In our interviews, many IHE faculty reported that this exposure has shaped and influenced their teaching practices. For some, it has resulted in adoption of different teaching strategies. Faculty described examples of using some of the questioning techniques described in TLAs to assess their students' understanding of materials. Others pointed to the use of the "Five E Model" in some of their classes.[26] Others mentioned that, where possible, they allow students to try alternative methods of problem solving rather than using those demonstrated by the instructor. For faculty who already use these strategies, the predominant impact for them was validation that their practices are grounded in research and considered among the best practices.

The impact of the MSP on IHE teaching strategies is significant, as many faculty in higher education are steeped in the tradition of lecture-based format for courses. Thus, the openness and willingness to embrace different modes of practice represents a crucial element in changing the pipeline of teaching practices from K-16. As mentioned in Chapter 4, deans interviewed at the IHEs were quick to point out that the "professional development" faculty are receiving is one of the major benefits from participation in the MSP. Comments from IHE team leaders also supported this view as many expressed concern that trying to view MSP participation as research was not acknowledging the most significant aspect that the MSP appears to be having on faculty, which is its impact on pedagogy.

The impact of these changes on student learning has been difficult to determine. Faculty pointed to anecdotal evidence which suggested students had deeper conceptual understanding. However, few had opportunities to carry out a systematic assessment that could determine the impact of changes in teaching practices on student learning. Although most faculty were convinced of the benefits of these changes in teaching practices, some voiced concerns that students may perceive inquiry-based courses as more difficult, a perception which could lower course enrollment and reduce favorable teacher evaluations. In subsequent years, our IHE interviews will continue to include questions about the effect of these changes in IHE faculty teaching practices.

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26 The Five E model is an instructional model that suggests that a natural learning process contains the following elements: engage, explore, explain, elaborate, and evaluate

Instructional Content

Results from TIMSS indicate that relative to other countries, the math and science curriculum in most U.S schools opts for breadth over depth – "a mile wide and an inch deep," as the popular description has it, which may account for its poor performance on TIMSS.[27] Our teacher survey included a substantial section on instructional content, where teachers reported the number of topics covered in a course and the amount of time spent on each topic. We used this data to explore this concept of "breadth over depth" by examining the relationships between school-level variables, including PSSA achievement data, and teacher responses on the instructional content portion of the teacher survey. The purpose of this exploration is to guide future analysis and inform the upcoming decision of whether to include this section of the survey in the follow-up teacher survey that will be administered in Year Four.

In this exploratory analysis, we calculated a *diffuseness of instruction* score for each math teacher who responded to the survey. The value of this score can range from zero to one; scores near zero indicate that many topics are covered with relatively little time on topic (more diffuse instruction), and scores near one indicate fewer topics covered and more time spent on each topic (less diffuse instruction).[28] We then examined whether the diffuseness of instruction score for all teachers in a school correlated with the following three school level factors:

- school-wide math achievement in the school;
- school-wide math over-achievement or under-achievement relative to a model that predicts achievement in a school based on its demographics;[29]
- teachers' rating of the influence of curriculum frameworks or curriculum guides on their instructional practices.

The first two correlations assess whether these data are consistent with a hypothesis that student achievement is higher when instruction is less diffuse. The third correlation studies the relationship between adoption of the math curriculum framework and diffuseness of instruction, shedding light on a

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[27] The description "A mile wide and an inch is deep" is taken from *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education,* http://ustimss.msu.edu/splintrd.pdf accessed on May 17, 2006.

[28] The method of calculating the diffuseness score was formulated to achieve a normalized score in the range of zero to one that behaved consistently for a wide variety of patterns of instruction. The formula is adapted from entropy analysis. First, we calculated the proportion of time p_t spent on each topic covered in the course. The diffuseness score d was then calculated as follows: $d = \frac{-\sum p_t \log_2 p_t}{\log_2 N}$, where N is the number of topics on the questionnaire.

[29] This model, developed last year and presented in detail in the Year Two report, allowed us to compare each MSP school with peer schools in Pennsylvania that serve similar populations. Using statewide data, we created a statistical model that predicted student achievement based on a set of school level demographic variables that are known to correlate with student achievement: socio-economic status, race/ethnicity, limited English proficiency, and geographic locale (rural, urban, etc.). We then determined how each MSP school's actual student achievement compared with the achievement level predicted by the model.

hypothesis that the curriculum framework helps teachers to focus on appropriate topics for the grade level they are teaching, and to avoid topics that are supposed to be covered in other grades.

The diffuseness of instruction score did not significantly correlate with any of these school level factors. The hypotheses were not confirmed; however, it is important to note they were not refuted either. There are several significant limitations of this dataset that may have led to the inability to detect correlations in this exploration. First, the course content section of the teacher survey used only about 50% of the topics that were in the original SEC. As described in the Year One report, this reduction was necessary to achieve a manageable survey length. Second, at the time this exploration was performed, we did not have the ability to link teachers who responded to the survey with the individual achievement scores of their students. Third, due to survey sampling and non-response, we did not receive course content data from all teachers in the MSP schools. Finally, the PSSA posed constraints as an achievement measure. It was administered only in math and only in grades 3, 5, 8, and 11 in 2004, the year of the survey. These constraints meant the diffuseness scores had to be aggregated for teachers in a school. For example, diffuseness scores were aggregated for teachers of grades 9-11 in the test of correlation with the 11th grade exam. Yearly testing would have enabled us to look at the relationships at a finer, grade-level granularity.

In preparing to re-administer the teacher survey in Year Four, we will weigh the results of this exploration along with other potential uses of the instructional content data, as well as the time and effort this section of the survey demands of the teachers responding, in order to decide whether and in what form to include the section again.

Summary

The findings from case study data discussed in this chapter indicate that the MSP professional development activities have some impact on changing teacher instructional practices. Teachers report better understanding of what is needed to change instructional practices. Moreover, classroom observation data suggest that some teachers, particularly elementary math teachers, are beginning to implement practices encouraged by the MSP. Science teachers appear to face a number of challenges in changing their practices. Some challenges, as highlighted in Chapter 4, have to do with planning and preparation time. However, other factors, such as awareness of what inquiry practices are and the wide variety of approaches they encompass, may also have limited science teachers, particularly high school science teachers, from engaging in these practices. It will be interesting to observe whether the MSP is able to help science teachers, in particular, to overcome these obstacles in changing instructional practices.

The extended analyses of the baseline data from teacher and principal surveys were also illuminating. Scale scores based on teacher reports of the amount of instructional time spent engaging in practices encouraged by the MSP, such as active learning, communicating science, and practicing scientific habits of mind, were in the lower ranges of our scales and are areas that the MSP hopes to improve. Overall teachers responded in the *little* to *some* range. Analyses of the principal survey indicated that principals were comfortable engaging in activities to support teachers in their efforts to change in instructional practices, and suggested that principals' content knowledge may be an important factor in their ability to serve as instructional leaders.

Finally, we learned that the MSP is continuing to have an impact on IHE pedagogy. Through participation in MSP activities, IHE faculty are learning, and more importantly, implementing the research-based teaching strategies in their courses. We think this is a significant impact of the MSP and discuss this finding in more detail in Chapter 7.

6. Student Outcomes and Course-Taking

The fourth research evaluation question focuses on student performance: "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?" The bottom line for the MSP is to demonstrate improved student learning in mathematics and science. This imperative 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.

Ultimately, our assessment of student learning seeks to measure changes in student outcomes and course taking over the term of the project and determine to what extent these changes can be attributed to the MSP interventions. At this point in the project, only limited analyses of effects on students are possible. In this chapter we discuss the current status of this effort.

The chapter first reviews some of the information about achievement measures and the achievement of MSP schools at baseline, which was presented in the Year Two report. It then describes the results of statistical modeling to begin to assess achievement changes during the term of the project. The chapter presents plans for more comprehensive analyses that will be possible as the MSP progresses and more data become available. We then discuss the performance of MSP districts in math and science, relative to benchmarking goals the project has established. Finally, we examine patterns of student course-taking to assess changes in enrollment in challenging math and science courses. The analyses draw on data collected over the course of the evaluation, as well as statistical models that we created to compare the performance of MSP schools with comparable non-MSP counterparts.

Student Outcomes

As detailed on the Year Two report, one of the project's 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. Beginning in 2006, the PSSA will cover grades 3 through 8 and grade 11, in reading and mathematics. Notably, there is no PSSA science exam. PDE plans to initiate one in 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.

The PDE reports school-level PSSA performance levels publicly, and we are collecting this information on MSP districts and other districts statewide. The non-MSP districts can serve as a comparison in some analyses, in order to examine whether changes observed in the MSP districts are mirroring statewide changes or whether gains can be plausibly credited to the MSP project.

To supplement this public data, we are building a large database from participating school districts that includes student-level math (and reading) PSSA results from MSP school districts dating back to 2000-01; teacher-student links during the years of the project, student course-taking data, and detailed information on teacher participation in the project. Our statistical models will use these data to test whether participation in MSP activities can be linked to student achievement gains.

The data on science achievement are less rich. Because the PSSA does not include a science exam, the MSP project is administering an alternative science test. This test is provided by the PROM/SE[30] Math and Science Partnership at Michigan State University, and is based on 1995 TIMSS. This evaluation therefore has no access to science achievement data from before the MSP project started. In addition, since the science test is not administered statewide, we are not able perform statewide comparisons (as we can in math). While the data permit us to observe whether science achievement increases over the course of the project, it will be more difficult to determine whether these changes are mirroring state or national changes, or can be plausibly credited to the MSP project. Finally, the PROM/SE assessment uses a matrix sampling design, which is not intended to produce student-level scores.[31] Results must be aggregated across groups of students to produce valid and reliable measures.

Baseline Achievement through 2004

As a starting point, it is worthwhile to review baseline achievement data presented in last year's report. In order to describe the baseline performance of MSP schools, we first compared the schools to statewide averages, using the percentage of students scoring *advanced* or *proficient* on the PSSA mathematics exam in 2003-04. We found that the NSF MSP schools generally outperformed statewide averages, and that PDE MSP schools generally underperformed the statewide averages. However, that simple comparison did not take into account the student populations served. For example, schools serving relatively disadvantaged student populations might excel at educating their students, yet perform poorly when compared to other schools in the state that serve relatively advantaged student populations.

To account for differences between schools, in the year two evaluation we created a statistical model that predicted student achievement based on a set of school-level demographic variables that are known to correlate with student achievement. In essence, this analysis allowed us to compare each MSP school with peer schools in Pennsylvania that serve similar populations. The demographic variables in the model

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

[31] In a matrix sampling assessment design, different sets of items are administered to different students in order to cover more of a domain than would be possible if all students received the same set of items.

include socio-economic status, race/ethnicity, limited English proficiency, and geographic locale (urban, rural, etc.). This model produced a very good fit to the student achievement data across Pennsylvania schools, confirming that the demographic variables are highly correlated with achievement. This analysis suggested that, at baseline, there is strong evidence that NSF MSP schools are somewhat better than average, after controlling for student demographic characteristics. For PDE MSP schools, the results were mixed: elementary schools performed better than predicted, while middle schools and high schools underperformed. The results for individual schools in the MSP project also showed that MSP schools represent a broad range of student demographics, and in this model some under-perform their peers and some out-perform their peers.

Changes in Achievement through 2005

As a first step in assessing changes in achievement, we created a matched comparison group of Pennsylvania school districts, designed to match the MSP districts in 2003, at the time the project began. Assuming the matching worked well, *if the MSP project had not taken place* we would expect both groups' achievement trajectories during the period 2003-08[32] to be similar. Given that the MSP project is taking place, if the MSP districts perform differently than the comparison group districts during 2003-08, it suggests that the MSP project is responsible for the difference. While this is not as rigorous of an analysis as would be possible in an experimental design, where districts are randomly assigned to participate in the MSP or not, it may help to build a plausible argument that the project had an effect on achievement. For this matched comparison group, we use Pennsylvania districts because they all utilize the PSSA exam, and district-wide results are available publicly. However, because no statewide science exam is administered, this comparative analysis is confined to math achievement. Appendix F explains the sources of data and processes used to develop the matched comparison group.

The result of this process is a comparison group that appears very similar to the MSP districts on many important variables that are frequently observed to predict future achievement. These include: prior PSSA math and reading scaled scores (from 1998 through 2003), the trends of change in those scores, the percentage of students who are in low income families, the percentage of minority students, attendance and graduation rates, the geographic locale (urban, rural, etc.), and the average educational attainment of adults in the community. Overall, we consider this balance to be reasonably good; however we were not able to achieve balance on all variables. Notably, while the overall percentage of minority students is well balanced, the percentage of Hispanic students is not. We also did not achieve balance on district size (enrollment) and the total population in the community.

The PDE discontinued reporting statewide, scaled scores in 2004. Thus, after having used a six-year history of math and reading scaled scores in forming the matched comparison group, we must use

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[32] While the project ends in 2008, results from the 2008 PSSA might arrive too late for analysis for this evaluation. In that case, we will investigate achievement through the year 2007.

proficiency levels in models that assess changes in achievement since the project began. For this, as in the analysis performed last year, we use the percentage of students scoring *advanced* or *proficient* on the PSSA.

Using a form of generalized linear modeling, we estimated the effect of participation in the MSP project on the percentage of students who scored *advanced* or *proficient* on the 2005 PSSA, controlling for the percentage of students who scored *advanced* or *proficient* in 2003. This analysis was repeated for six exams: math and reading exams in grades 5, 8, and 11. The variables mentioned above that did not balance well in the matching process were included as covariates in these models.

We found no discernable difference between MSP districts and the comparison districts. The lack of a measurable effect of the MSP project on the 2005 PSSA math results is not necessarily surprising. The exam was administered at the end of the 2004-05 school year, the first year of full implementation of all MSP activities. For the project to have such immediate impact on PSSA results is unlikely. When we repeat this analysis in future years we will include data from additional years of testing, thus capturing more of the potential effects of ongoing project implementation on achievement. One limitation of this analysis is that it could not consider the variance in implementation across MSP districts. Districts not fully implementing the MSP intervention are likely to dilute any effects that occur in districts that are implementing the intervention faithfully. It is also possible that the PSSA may not be very sensitive to the types of student learning that are enhanced by the MSP intervention.

All six statistical models showed a statewide tendency for the percentage of students scoring *advanced* or *proficient* to increase. This result confirms that simply observing changes in PSSA results within the MSP districts, without using a comparison group, is not an accurate way to measure project effects. The scores are increasing statewide for reasons other than the MSP project. The full explanation for this trend is not known, but it is probably driven by an increased focus on math achievement due to the NCLB law. MSP districts would most likely have experienced similar trends of increased achievement even if they had not participated in the MSP project. This fact is worth keeping in mind while considering the benchmarking results that are presented later in this chapter.

Future Analysis of Changes in Achievement

The database we are currently assembling will enable a variety of more fine-grained analyses in future years. As mentioned above, the database will include longitudinal student-level achievement data dating back to 2000-01, detailed teacher participation data, and teacher-student links that enable us to assess the relationships between participation in the project and the achievement of students who are taught by the participating teachers.[33]

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[33] The assessment and evaluation team has had notable success over the past year in working with MSP districts to obtain the necessary data, assigning unique permanent identifiers to the data records, and de-identifying the data. This is an ongoing process and districts' fulfillment of the data requests has varied but continues to improve.

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These analyses are not included in the current report for two reasons. First, the database currently has only a single year of data for most students in the MSP; two or more years of student test scores are present for only a small subset. This is due to the PSSA testing schedule through 2005, where students were tested only in grades 3, 5, 8, and 11, combined with incomplete historical test data from many districts, and in some cases poor identifiers on older test records such that we are not able to match them across years. This situation is expected to improve substantially with the 2006 PSSA results because another year of data will be added to the database, PDE will have added tests in additional grades (4, 6, and 7), and we expect some districts to supply more complete historical data. Second, teacher-student link data are just now becoming available to the evaluation team, for a subset of MSP districts, as this report goes to press. As these data issues begin to resolve over the coming months we will devote increasing attention to these more sophisticated analyses.

The remainder of this chapter focuses on the performance of MSP districts relative to benchmarking goals the project has established.

Math Benchmarking

Benchmarking refers to an activity required by the NSF MSP grant, for the project to report annually on progress toward end-of-project goals related to student achievement and course taking. Here we summarize the benchmarking results for the past two years. The numbers in the tables are the number of districts meeting the specified targets.

1. For 36 of 40 (90%) of the NSF MSP districts to have 75% or more of their grade 5, 8, and 11 students at the *advanced* or *proficient* level.

Number of districts meeting target (goal: 36 in each cell)	2004	2005
Grade 5	13	20
Grade 8	7	12
Grade 11	4	2

2. For 36 of 40 (90%) of the NSF MSP districts to have 10% or fewer of their grade 5, 8, and 11 students at the *below basic* level.

Number of districts meeting target (goal: 36 in each cell)	2004	2005
Grade 5	13	28
Grade 8	7	10
Grade 11	2	1

3. For 15 of 17 (90%) of the NSF MSP districts with reportable black enrollment to have 50% or more of their grade 5 and 8 students in this subgroup at the *advanced* or *proficient* level.

Number of districts meeting target (goal: 15 in each cell)	2004	2005
Grade 5	5	6
Grade 8	1	2

4. For 31 of 34 (90%) of the NSF MSP districts with reportable enrollments of economically disadvantaged students to have 50% or more of their grade 5 and 8 students in this subgroup at the *advanced* or *proficient* level.

Number of districts meeting target (goal: 31 in each cell)	2004	2005
Grade 5	18	27
Grade 8	6	19

There is a clear trend of improvement, but many districts fail to meet the target. However, caution is warranted in interpreting these results. Year-to-year comparisons on these benchmarks are problematic because they compare different cohorts of students. Moreover, as noted above, the benchmarking results are a relatively simplistic way to assess project impact because they cannot distinguish between changes that occur due to the MSP project versus changes due to other independent forces that are causing general statewide improvements in student proficiency levels.

Science Benchmarking

This year the project has established benchmarks for Science based on the PROM/SE assessment. Although this assessment is not designed as a proficiency test, we decided to utilize a set of three performance levels reported by Michigan State University (MSU) for use in benchmarking. This assessment includes almost all of the 1995 TIMSS items, and MSU reports how well each district performed on these items relative to the U.S. performance on TIMSS in 1995. Using these reports, the project has classified each district as performing: *notably higher* than the U.S. performed on TIMSS 1995; *about the same* as the U.S. performed on TIMSS 1995; *notably lower* than the U.S. performed in 1995.

At the request of this project, MSU also aggregated the performance of all black and economically disadvantaged students who took the PROM/SE assessment across all MSP districts, and produced similar reports for each of these subgroups.

For benchmarking, the MSP set the following end-of-project goals for achievement on the PROM/SE science assessment. The numbers shown in the tables are the numbers of districts meeting the specified targets in the past two years.

1. For at least 24 of 40 (60%) of the NSF MSP districts at grades 4, 7, and 10 to be classified as *notably higher* than the U.S. performed on TIMSS 1995.

Number of districts meeting target (goal: 24 in each cell)	2004	2005
Grade 4	19	17
Grade 7	13	4
Grade 10	3	10

2. For at least 36 of 40 (90%) of the NSF MSP districts at grades 4, 7, and 10 to be classified as *about the same* or *notably higher* than the U.S. performed on TIMSS 1995.

Number of districts meeting target (goal: 36 in each cell)	2004	2005
Grade 4	32	32
Grade 7	27	23
Grade 10	16	20

3. For black students at grades 4 and 7 to be classified as *about the same* or *notably higher* than the U.S. performed on TIMSS 1995.

Number of districts meeting target (goal: *about the same* or *notably higher* in each cell)	2004	2005
Grade 4	*notably lower*	*notably lower*
Grade 7	*notably lower*	*notably lower*

4. For economically disadvantaged students at grades 4 and 7 to be classified as *about the same* or *notably higher* than the U.S. performed on TIMSS 1995.

Number of districts meeting target (goal: *about the same* or *notably higher* in each cell)	2004	2005
Grade 4	*notably lower*	*notably lower*
Grade 7	*notably lower*	*notably lower*

Unlike the trend of improvement seen in math, there is no clear trend in these results. The subgroups have not yet improved, and the number of districts meeting the benchmarks at fourth grade is similar in both years. At the tenth grade level more districts met the benchmarks in 2005 than in 2004, however the opposite is true for seventh grade. The same caveats noted above for interpreting the math benchmarking results also apply to these science results.

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 source of these data is the *District Profile of Math and Science Indicators*. The profile is compiled annually from a survey that is distributed at the end of each academic year to 137 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 in 2004-05 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 new data serves as a baseline for the school year 2003-04 (project Year Two) and we will continue to monitor for changes 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 similar course completion with their regional peers (see Table 6-1). Some slight increases (Level I Math and Physics) and decreases (Level III Math) are noted, but they are minimal (between 1% and 4%). NSF MSP districts show less variability in range of implementation than do their non-MSP peer districts in Level I Math and Chemistry. 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 earlier years, although we will continue to look at this more closely for trends in future years of the project.

Math and Science Collaborative

Summary Report of Successful Course Completion from the 2004-05 District Profile of Math and Science Indicators

Percent of Students Successfully Completing Listed Courses by Graduation in MSP Districts as Compared with the Data From All Reporting Districts in the Region

	Project Year One		Project Year Two		Project Year Three	
Course	**2002-03 Total Geographic Sample % And Range[3]** "C" or better grade	**2002-03 NSF MSP Districts Total Sample% And Range[4]** "C" or better grade	**2003-04 Total Geographic Sample % and Range[5]** All Passing grades	**2003-04 NSF MSP Districts Total Sample% And Range[6]** All Passing grades	**2004-05 Total Geographic Sample % and Range[5]** All Passing grades	**2004-05 NSF MSP Districts Total Sample% And Range[6]** All Passing grades
Level I Math (Algebra I)	72% (37% to 100%)	74% (37% to 100%)	89% (56% to 100%)	91% (62% to100%)	91% (14% to 100%)	93% (70% to100%)
Level II Math (Geometry)	61% (19% to 95%)	60% (20% to 92%)	82% (33% to 100%)	86% (39% to 100%)	83% (38% to 100%)	83% (40% to 97%)
Level III Math (Algebra II)	66% (33% to 100%)	67% (24% to 92%)	75% (33% to 100%)	76% (36% to 100%)	78% (40% to 100%)	77% (40% to 97%)
Biology I	81% (38% to 100%)	77% (24% to 100%)	92% (61% to 100%)	91% (61% to 100%)	94% (53% to 100%)	94% (53% to 100%)
Chemistry I	63% (31% to 98%)	62% (31% to 98%)	72% (28% to 100%)	72% (28% to 98%)	70% (9% to 100%)	70% (33% to 97%)
Physics	35% (3% to 93%)	33% (7% to 93%)	40% (4% to 96%)	41% (7% to 96%)	37% (0% to 99%)	41% (0% to 98%)
	[1]Based on 95 districts	[2]Based on 38 districts	[3]Based on 82 districts	[4]Based on 38 of 40 districts	[5]Based on 90 districts	[6]Based on 36 of 40 districts

Table 6-1: Summary of course completion data for NSF MSP districts and regional peers.

Each year the MSP benchmarks progress of districts in Successful Course Completion (as related to Goal 1, Benchmark A as noted in the project's annual report).[34] All course levels show an increase or holding pattern in the number of districts meeting or exceeding these benchmarks, with the exception of Geometry and Chemistry. Historically, findings from the Profile of Math and Science Indicators have been much less reliable and more variable for Geometry since policy and curricula are more likely to emphasize a different sequence and course alignment than was the case in a more traditionally arranged math curriculum of the past. Many districts opt to move students through an algebra 1 and 2 sequence or an integrated math sequence rather then interrupting the series with a geometry course. Benchmarking data reveal that 25 districts meet or exceed the 90% average of student success for Algebra 1 (Math Level 1) as compared to only 7 districts at baseline and 21 districts at Year Two. Similarly, 23 districts meet or exceed a 70% benchmark for Algebra 2 as compared to only 10 at benchmark and 22 in Year Two. Biology

[34] Goal 1: To increase the K-12 students' knowledge of mathematics and science through an increase in the breadth and depth of their participation in challenging courses with coherent curricula. Benchmark A: By the end of Year Five, increased student knowledge will be demonstrated through 90% of the 40 K-12 districts (36) will attain the percentages of seniors having completed identified courses or their equivalents by graduation. The courses and benchmark percentages are Algebra I (90%), Geometry (80%), Algebra II (70%), Biology (93%), Chemistry (75%), and Physics (50%).

findings indicate an increase to 22 of the 40 districts meeting benchmark as compared to 8 at baseline and 18 last year. Chemistry shows a slight decline to 14 districts compared to only 8 at baseline and 15 in Year Two. Physics remained steady at 7 districts meeting or exceeding benchmark as was true in Year Two and 6 districts at baseline.

Summary

A statistical model assessing change in PSSA math proficiency relative to a group of matched Pennsylvania school districts did not find evidence of project impact. This is unsurprising because the most current PSSA data are from very early in the project's implementation. The same analysis found that there is a statewide trend of increased proficiency on the PSSA, a fact that is useful when interpreting benchmarking trends, where more districts are meeting the math targets set by this project. There is no clear trend in science.

7. Conclusions and Issues for Consideration

The MSP is in the third year of a five-year implementation program. It is difficult and perhaps premature to draw conclusions based on the interim data that is available thus far. The purpose of this chapter, therefore, is to highlight key findings that emerged during the Year Three evaluation and identify issues meriting further attention and analysis.

Throughout this Year Three report, we have used the MSP logic model as a unifying framework to discuss our findings. In this final chapter, we follow a similar pattern, organizing our highlights and key findings within this structure and discussing some of the noteworthy elements within each logic model component. In the section that discusses outcomes, we aggregate our findings into broader themes that reflect our thinking about next steps, which may assist the MSP in its planning for Year Four.

Key Findings on Inputs

As described in the logic model, the LATs are one of the key inputs that guide the planning and implementation of MSP activities. In the Year Two report, we noted that it was critical for each LAT to have an engaged leader and for the team members to have sufficient time to attend the LAAs. In large part, these issues have been resolved, as the LATs have exhibited increased independence, and LAA attendance has generally improved, although administrative participation remains a challenge. Successful LATs have been influential not only in implementing the MSP interventions, but more generally through their involvement in district strategic planning. Moreover, across the K-12 districts, distinct models of participation are emerging. For example, in some districts, the MSP flag is being carried by motivated teachers who recognize the value of the partnership, while in other districts, the administrators are the ones who are championing the project and recruiting the teachers to participate. Both models seem to be equally successful, depending on the district context. One of themes that emerges from this observation is the nonlinearity of the buy-in process. That is, simply having administrators take the lead does not ensure that teachers will fall into line; nor is it a question of having teachers take charge with administrators supporting them. A convergence of teacher and administrator buy-in seems most likely to lead to a successful LAT.

The IHE LATs are also critical in IHEs, but it is more difficult to discern the underlying processes that account for the success of these teams. In some IHEs, the LATs were largely driven by a few individuals who were solely responsible for keeping the faculty involved. Other IHEs have LATs with more extensive faculty involvement. Both seem to work reasonably well within the context of their institutions. As the project progresses we will continue to note the implication of how LATs are configured and the impact that has on partnership building. One question the MSP may consider in relation to this is:

- What factors have contributed to the success of LATs at both K-12 districts and IHEs and what steps can be taken to incorporate these factors into the project design?

Key Findings on Intervention Strategies and MSP Activities

Completing the planned MSP activities is a critical first step toward the intended outcomes. Therefore this report gives considerable attention to the ability of the MSP to carry out the planned activities and to the quality of these activities. We found that the MSP has been very successful in completing the planned steps of Year Three. Moreover, the majority of MSP activities were implemented as planned, and were well received by participants.

Of the MSP professional development activities, the TLAs continue to show improvement, with the academies demonstrating more integration of content-based pedagogy and leadership development. Most IHE faculty that we spoke with described the TLAs as helpful in increasing their awareness of pedagogy; a few were enthusiastic about their involvement in planning the TLAs for the upcoming summer. As highlighted in the Year Two report, one strength of the TLAs is the opportunity they provide for direct interaction between K-12 and IHE faculty, which facilitates awareness and appreciation for different cultures. In fact, there are a few examples of faculty and K-12 teachers maintaining contact with each other after the summer academies, showing preliminary evidence of partnership building. As described in Chapter 4, two of these examples were of K-12 teachers becoming adjunct faculty at the IHEs to teach evening courses.

A primary expectation of teachers participating in the TLAs is that they will be able to serve as a resource for teachers in their districts through the implementation of on-site academies. During Year Three, we observed a number of the on-site academies and noted a fair amount of variation in the districts' implementation of the academies. Although some degree of customization is to be expected, we noted that many of the on-site academies had a "reactive" structure, with teacher leaders forced to deal with unplanned changes at the last minute. Due to time constraints, varying participation rates, and limited resources—teacher leaders often had to make decisions on how to modify these school-based academies to adjust to the prevailing conditions. For example, teacher leaders may have to change the amount of content covered in the workshops, the duration of the workshops, and how resources will need to be allocated based on participation size. Though not surprising that these adjustments would have to be made, we raise questions about the degree to which these on-site academies can be modified without losing the original intent and integrity. Because the on-site academies are a critical element to the development of communities of learners, the evaluation team will continue to monitor, through our case study districts, the types of modifications that are being made to the on-site academies, the conditions that create them, and their impact of the changes. One question the MSP may consider in strengthening the on-site academies is:

- What guidance can be given to teacher leaders on adapting academy material for presentation in their home schools?

The CDSs, though well received by attendees, continue to face challenges with regards to marketing and participation by K-12 teachers. Overall, attendance at CDSs was lower than planned by the project. One reason may be that external incentives for participation were low. Participating teachers can receive credit towards their state-mandated professional development requirements, however most had recently fulfilled those requirements for a three-year cycle, and may have seen little need to begin working toward fulfilling the next round of requirements. In addition, the IHE-led CDSs face competition from activities sponsored by other organizations (e.g. science museums, for profit teaching organizations, etc.). Finding ways to encourage teachers to sign up for the IHE-led CDSs presents an ongoing challenge for the MSP. This year the MSP has made a number of efforts to increase participation, and it will be interesting to see if they are successful. The IHE faculty continues to try to identify unique ways to market and highlight the benefits of the CDSs to the K-12 community.

- What steps can be taken to increase awareness and interest among eligible teachers in the content deepening seminars?

Key Findings on Outputs

In addition to teacher and principal leaders, teacher fellows (TFs) are one of the major outputs of the MSP activities. While the other MSP activities and their outputs are aimed at reaching a broad audience of teachers, the TF program encourages the development of relationships between individual teachers and higher education faculty members. Thus, the TF program continues to be a critical link in building the partnerships between K-12 and IHEs.

Last year we heard from the TFs that spending a full year on an IHE campus was important in building relationships with IHE faculty members. This theme was echoed in our interviews this year. TFs who participated for a semester said that if given the opportunity again, they would opt for a yearlong term. However, when they were initially making this decision they considered factors such as being out of touch with their students, not really knowing what to expect from the experience, and concerns about salaries and retirement benefits. Finding ways to address these concerns before TFs commit to the duration of their participation may help to increase the likelihood that teachers will participate for a full year and gain the maximum benefit from the experience.

Another concern that was introduced in the Year Two report was whether teachers would return to their home districts after participating in the TF program, as expected by the project. This did not appear to be an issue this year, as all of the fellows we interviewed said they planned to return to their districts. It will be interesting to determine if TFs' roles in their schools and districts changes after the fellowship experience, and if so, how. As the MSP considers issues of sustainability, the long-term impact of the TF program will need to be carefully considered. Most IHE faculty and TFs felt this activity should be sustained, but realized it would be a great investment. It is difficult to make the case for the investment without a better understanding of the long-term impact on the school and/or district. One question that emerges from these findings is:

- What are the expected long-term impacts of TFs, both in their schools and districts as well as on the IHEs, and how can these impacts be used to increase the likelihood of sustainability?

Key Findings on Outcomes

Although it is too early in the project to see achievement of long-term outcomes, examples of short- and mid-term outcomes are becoming evident, such as increased awareness of research-based instructional practices and materials, development of 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 the logic model.

Variations in K-12 Participation

Patterns among the districts are beginning to emerge. The most striking is, in many ways, the most logical. In the case studies, districts that show the most evidence of MSP impacts are those that are doing the most to implement the program, such as having high attendance at MSP activities, following project requirements, and providing teachers with an opportunity to reflect on what the MSP means within the context of their own teaching. Though this theme is intuitively obvious, it is important to emphasize, because it suggests that the MSP model seems to be working at the teacher level and the theory of action upon which it is based is credible. Harder to discern is whether high levels of participation in the MSP are facilitated by certain district characteristics, making district involvement easier, or if participating in the MSP strengthens certain district characteristics whereby the impact of the MSP is much more evident. It is difficult to answer this question at this early stage of our analysis. We have, for example, observed that a critical mass of teachers and administrators need to be onboard for the MSP to really take hold in district. What this critical mass is and how it is formed are questions we hope to address as our case studies continue.

- What factors drive the level of district participation in MSP, and how can the project capitalize on these factors to enhance participation?

Competing Reform Initiatives

Increasing teacher and administrator awareness of research-based practices and materials is an initial step toward changing practice. Data gathered in Year Three suggests that, for science teachers in particular, it was difficult to take the next steps toward implementing the reforms in their classrooms. Competing math reform initiatives as well as inadequate planning and preparation time for inquiry-based activities were common concerns. Science teachers described how short class periods limited their ability to implement inquiry-based practices. Moreover, in analyses of the teacher and principal survey data, we observed that responses regarding science were consistently slightly lower than responses regarding math. Whether the scale was measuring time spent on active learning, or emphasis of professional development on certain topics, the science responses ranked lower than math responses, with few exceptions. This finding is not surprising, and may in fact be a natural outgrowth of the earlier development of standards in math and the emphasis on testing and accountability that has been present for some time in mathematics and not present in science. This should change as testing and accountability ramps up in science, and the MSP will hopefully accelerate this change. Finally, in some lower performing districts these difficulties are not confined to science. Struggles to improve in mathematics under the pressures of NCLB have attracted numerous competing reform initiatives that ultimately prevent the district from implementing any of them well.

- What are the implications to the MSP project that science reform tends to be lagging behind math reform, and what can the project do to address this issue?

IHE Recognition and Value of MSP Impact

Sustainability of the partnership between K-12 school districts and IHEs depends, in large part, on the IHEs recognizing the benefits of participating in the MSP. What are IHEs gaining as a result of participating in the MSP? Moreover, how do IHEs value the benefits they are receiving from the MSP?

Interviews with IHE faculty indicate that the one of the primary benefits they have received is exposure to pedagogy and in particular, inquiry-based teaching practices. Pedagogical professional development is not typically a priority for IHEs, especially with the current renewed emphasis on research and publication that is being seen in the IHEs participating in this project. Most faculty members, particularly STEM faculty, do not receive any formal training in teaching. Consequently they tend to teach they way they have been taught, which is typically using a lecture-based format. As a result of MSP participation, faculty have been exposed to different teaching strategies and this appears to be having an impact on their teaching practices. Most faculty members we interviewed who had participated in the TLAs reported that they are incorporating some of the concepts from the TLAs into their own classrooms. While this was not an explicit goal of the project, it might have been a byproduct that was anticipated by the PIs. Whether intentional or not, the ultimate effect may be improved teaching for undergraduates at IHEs. At issue, however, is whether there are existing mechanisms at IHEs to not only recognize but also reward faculty for their increased awareness and change in teaching practices.

With regards to promotion and tenure, many IHEs view faculty participation in the MSP as service to the community or teaching. This method of recognizing MSP participation is not of much value to faculty because they can gain service credits through less labor intensive methods than the MSP. Other IHEs are willing to recognize faculty participation in the MSP as research, provided that publications are forthcoming. For STEM faculty, this is a challenge since publishing in one's own discipline is more widely acknowledged as scholarly research than publishing in other fields (i.e. science or math education). Faculty professional development, however, appears to be the area where the MSP is having a major contribution. Yet, there are few mechanisms in place to reward faculty for this. Moreover, junior faculty, who potentially have the most to gain from exposure to the MSP teaching strategies, are being discouraged by more senior faculty from spending too much time engaged in MSP activities because it is considered "risky" to their careers. Increased participation of the IHE Deans may be important in helping to counterbalance this sentiment. We think that this is a key issue for the MSP, not only in terms of sustainability, but also in terms of how the MSP communicates the value of its activities to the IHEs.

- Are incentives for IHE participation adequate for promoting program sustainability and are there other approaches to rewarding participation that IHEs should consider?

Managing Change

Year Three was a pivotal phase of the MSP. The first and second years of the project were focused on establishing infrastructure, which required rather rigid adherence to MSP policies. However, now that this infrastructure is in place, the MSP appears to be more accommodating and more flexible in its activities, as well as in the roles and responsibilities of MSP staff and participants. The nature of change in complex education settings, as evidenced by the experience and findings of this project, is slow, incremental, abrupt, and non-linear. Managing the fluid nature of change, and eventually the sustainability of the project, will require continued adaptation within appropriate limits. Defining these appropriate adaptations while maintaining fidelity to the MSP design presents a current and crucial challenge for the MSP.

This is an interesting phase for the MSP because it is the beginning of the transformation of the MSP from a research and development project supported by the NSF to a regionally (or locally) owned institution embraced by the community. The process of this transformation will clearly be an area of interest for the evaluation team. A key component of this transformation is the MSP coordinators, who are responsible for coordinating MSP activities in the district. As the project progresses, the MSP coordinators will be supported by the IUs, who may have different expectations of MSP coordinators and their role in the districts.

Additionally with greater flexibility in response to K-12 and IHE partners, comes added risk for a dilution of the MSP program and its theory of action. As the MSP adapts to accommodate institutional contexts (a necessary step to build for sustainability), it will be important to consider fidelity of implementation in regard to outputs and outcomes, as well.

- Are there additional adaptive responses the MSP and partners need to consider and implement, in order to balance fidelity of implementation with the realities of inducing change in education settings?

Communication

Communication continues to be a key issue in a project as large and complex as the MSP. Each of the evaluation reports comment on how communication strategies to continue evolve. Year Three presents evidence of continued improvement of communication with K-12 and IHE partners. While improvement has been noted, there is still room for growth. The project is still perceived by some K-12 and IHE partners (or at least members of these institutions) as inflexible or non-responsive to specific needs. Given the scope and breadth of this initiative, some confusion may have to be accepted as the norm and the project will have to decide what level of misperception it is willing to accept. As the role of the IUs in funding expands, issues of communication with these partners will become even more a priority.

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 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 indicated 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, who does not appear to be heavily involved in the MSP. 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 better inform institutions about its student placement strategy and strengthen their commitment to it?

Individual and Institutional Partnership

One of the key themes that emerged from our IHEs interviews and K-12 case studies is the complexity of partnership and the view that building the partnership is a responsibility shared by all involved in the MSP. Institutions can do only so much to foster partnership between individuals, and similarly individuals cannot force institutional partnership. Partnership requires mutual intent and benefit. As the project has progressed in Year Three, we have seen evidence of both a greater awareness of intents and benefits, and responsiveness by partners toward maximizing the benefits. A key question about sustainability is whether the relationships that have been built will continue after the NSF funding period is complete. Relationships take time to maintain, and if the institutions do not value them, there may not be sufficient motivation for the partnerships to continue. Our continued efforts in evaluation will focus on identifying and describing mechanisms of evolving partnership.

- What are the priorities for partnership and how is the MSP building a sustainable future?

Student Achievement

The achievement data that is currently available is from quite early in project implementation. Statistical models assessing change in MSP districts' PSSA math proficiency relative to a group of matched Pennsylvania school districts did not find evidence of project impact at this early stage. The same analysis did find a statewide trend of increased proficiency on the PSSA, a fact that is useful when interpreting benchmarking trends, where more districts are meeting the math targets set by this project. There is no clear trend in science. Over the next two years the evaluation will place increased focus on achievement outcomes and, to the extent possible, on developing plausible explanations for how the MSP project has influenced achievement.

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' perspectives, 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 12 case studies, seven school districts from the National Science Foundation-sponsored group and five 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 first 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 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.

The total MSP district population of 48 school districts was reconsidered in 2005 to determine the case study choices for Year Three. The various measures of participation and implementation were reconsidered, coupled with the research advantages of maintaining the same group of case study districts from Year Two. Little change in status was noted across districts based on participation and implementation data; not enough to warrant the addition or deletion of existing case study sites. Two low implementing districts were considered for deletion from the pool because they seemed to be opting out of the MSP project, however adaptive responses from both the MSP and the districts made these sites worth continuing to observe and explore.

We classified the 12 districts selected for case study into three tiers. The seven Tier 1 districts (four NSF, three 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. As one case study proceeded it became clear that this district had moved to a higher level implementation status and was thus reclassified as Tier 2 by the end of this year. Five districts classified as Tier 3 districts are considered "high implementers." These districts have been successful in completing most of the continued 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). Like last year, 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.

The focus of the case studies in Year Three expanded on the Year Two theme of "successful implementation" to move beyond professional development to pedagogical change. The goal was to increase focus on classroom instruction observations across the school year. Plans for Year Four (the last year for case studies) will include a more intense focus on pedagogical change and the impact based on evidence of student learning and conceptual understanding.

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 September 2005, the districts were reminded of our continued need for case study observations and interviews. Soon after, observers began communicating with the districts about their on-site professional development academies in order to schedule observation visits. Like last year, most contact with the districts occurred through the LAT point person. As was the case in Year two, 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 reflecting on our collaboration with districts about observations and interview schedules, it seemed that this year's district support in planning our visits were even less of a priority than last year.

In the Tier 3 districts, where possible, we again 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 often following up on last year's questioning, including LAT members and teacher leaders as well as district personnel for whom we were unable to connect with last year. We also 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. At the time of this reporting, we have conducted 44 classroom observations and have 7 more scheduled within a month of this report. For Tier 1 districts, we both observed at least one of their on-site academies if it was provided in their district, as well as conducting follow-up interviews to last year's conversations.

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. Continued extensive reporting is expected within the project next fall and in the Year Four evaluation report. Meanwhile, a third 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: Factor Analysis of Principal and Teacher Survey Data

The principal surveys consisted of sections pertaining to views and influences on mathematics and science instruction, current practices and policies regarding curriculum, instruction, assessment, and professional development, and district and IU support for improving schools. Each section had questions that had from 4 to 25 sub-questions using Likert-type scales (1 = strongly disagree; 5 = strongly disagree). The teacher surveys consisted of sections pertaining to instructional activities, assessments, instructional influences, classroom preparation, and professional development for math and science in high school or K-8. Each section had questions that had from 5 to 12 sub-questions. The goal was to develop scales that would summarize these sections.

Factor analysis was used to determine grouping of variables in each section. To be more specific, factor analysis was used to uncover the latent structure (dimensions) of a set of variables. In essence we used the factor analysis for the following purposes:

- To select a subset of variables from a larger set, based on which original variables have the highest correlations with the principal component factors.
- To validate a scale or index by demonstrating that its constituent items load on the same factor, and to drop proposed scale items which cross-load on more than one factor.

After factor analysis, a descriptive name was attached to each common factor once it was extracted and identified. The assigned name is indicative of the predominant concern that each factor addresses. At this point, the named common factors can now be used as independent or predictor variables. However, a reliability test is meaningful for all the factors before using them in subsequent analyses.

Reliability comes to the forefront when variables developed from summated scales are used as predictor components in objective models. Since summated scales are an assembly of interrelated items designed to measure underlying constructs, it is very important to know whether the same set of items would elicit the same responses if the same questions are recast and re-administered to the same respondents. Variables derived from test instruments are declared to be reliable only when they provide stable and reliable responses over a repeated administration of the test.

In order to test the reliability of the factors (or scales), Cronbach's alpha was calculated. Computation of alpha is based on the reliability of a test relative to other tests with same number of items, and measuring the same construct of interest (Hatcher, 1994). Alpha coefficient ranges in value from 0 to 1. The higher the score, the more reliable the generated scale is. Nunnaly (1978) has indicated 0.7 to be an acceptable reliability coefficient, but lower thresholds are sometimes used in the literature. For all of our scales, alpha > 0.65 (double-check). For each scale, dispensable variable(s) were identified by listing the deleted variable with the expected resultant alpha. If alpha was improved then the dispensable variable(s) were removed from the scale. In other words, the removing of a variable from the scale will make the construct more reliable for use as a predictor variable.

Once a scale was established, tests for normality (including the Shapiro-Wilk Test) were performed. When scales were normally distributed, comparisons between groups were made using a t-test or ANOVA where applicable. Where the distributions were not normal, comparisons between groups were made using a Kruskal-Wallis Test or Signed Rank Test where applicable. In all cases, p-values < 0.05 were considered evidence of differences not attributable to chance. All analyses were performed with use of SAS Software Release 9.1 (SAS Institute Inc., Cary, NC).

Appendix E: MSP Event Observation

An evaluation consultant attended LAA sessions held at Network Connections, one *Lenses on Learning* session at AIU, TLAs sessions, and a number of on-site professional development academies in case study school districts during Years One through Three. 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 Team Leader 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: Analysis of Student Achievement Data

This project gained access to a comprehensive existing database of more than 100 variables for each school district in Pennsylvania, courtesy of another RAND project. The database contains district-wide PSSA math and reading scaled scores from 1998 through 2003 and many other variables including school size, race/ethnicity of the student population, attendance rates, school expenditures, school salaries, percentage of school staff with master's degrees, and family income of the student population. It also includes community measures of wealth, educational status (years of education), age, employment, housing, and geographic locale (urban vs. rural, etc.). The data sources for this database include: Pennsylvania Department of Education,[35] the Common Core of Data from the U.S. Department of Education's National Center for Educational Statistics,[36] the Pennsylvania State Education Association, and the U.S. Census Bureau.

Beginning with the 501 districts in Pennsylvania, we excluded several districts that are not good candidates for matching, including a district that has no students and two large urban districts (Pittsburgh and Philadelphia) because they are very dissimilar from the MSP districts. Next we excluded the six MSP expansion districts because they will participate in the project for only part of the period of study (and thus are considered to be neither treatment nor comparison districts). Among the remaining 490 districts, we marked the 48 MSP districts (40 NSF and 8 PDE) as "treatment" districts and the other 442 as "comparison" districts. We then used a method called propensity score matching to develop a set of weights for the comparison districts. The weights are used in calculating weighted averages for the matched comparison group on variables of interest. For each variable of interest, if the matching process functioned well the weighted average across the comparison group will be similar to the average across the treatment group.

When we attempted to balance all of the more than 100 variables the result was poor balance on some important predictors of achievement such as prior achievement, percent minority, or percent low income. Therefore we prioritized the variables to ensure the most important ones would be well balanced. The resulting weights balance the treatment and control groups on all prior achievement measures, percent minority, percent low income, and a number of other variables that are often found to be predictors of achievement. Notably, while the overall percentage of minority students is well balanced, the percentage of Hispanic students is not well balanced. The MSP districts have, as a rule, very low Hispanic populations. Another variable that did not balance very well was district size (enrollment). Because these variables did not match very well, we included them as covariates in subsequent models.

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[35] 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=|

[36] http://nces.ed.gov/ccd/

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