WORKING
PAPER

Math Science Partnership of Southwest Pennsylvania

Year Two Evaluation Report

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Summary

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

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

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

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

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

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

- *Professional Development for Leadership* is accomplished through academies and seminars for K-12 educators and IHE faculty. The overriding purpose of these activities is to equip teachers with the pedagogy, content, and leadership skills necessary to become effective leaders in their institutions.
- *Curriculum alignment and pedagogical and course refinement* is accomplished at the K-12 level through the use of curriculum frameworks, and at the IHE level through the contributions of teachers who spend one to two semesters or a summer on the campuses.
- *Support for and dissemination of research based resources and tools* is primarily accomplished through conferences and networks of educators using research-based curricula.

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

Project Evaluation and Purpose of this Report

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

1. Have MSP partners developed and implemented a comprehensive intervention targeting math and science curriculum and achievement? If so, how?
2. Have institutional practices and support structures changed at K-12 districts and IHEs participating in the MSP? If so, how?
3. Have math and science instruction changed in K-12 districts participating in the MSP? If so, how?
4. In what ways have student outcomes and course taking changed in K-12 schools and districts implementing the MSP? If change occurred, what is the connection between implementation of the MSP plan and these changes?

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

Intervention Strategies

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

Professional Development for Leadership

Leadership Action Academies

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

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

Teacher Leadership Academies

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

During Year Two, TLAs were completed for elementary and secondary math and high school science involving 182 teacher leaders representing 38 of 40 NSF MSP districts. The higher education partners

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

Lenses on Learning

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

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

Curriculum Alignment and Pedagogical and Course Refinement

Math and Science Curriculum Frameworks

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

As the project moved into its second year, the focus shifted from development of the frameworks to their utilization within MSP strategies and activities, such as the TLAs, on-site academies, and *Lenses on Learning*. MSP staff report that the frameworks continue to serve as useful resources and tools for aligning

curricula. The Pennsylvania Department of Education recently developed a set of math assessment anchors to help align curriculum, instruction and assessment practices, so the Math Framework was refined this year to include these anchors. Additionally, in the course of creating the Science Framework, the project developed a set of grade level expectations, which are a resource to the PDE as it develops an official set of assessment anchors for science. This is one example of the evolving nature of the MSP project and the expected and planned shifting of emphasis across resources, strategies, and activities as the project matures. This evolution is an important component of long-term sustainability.

Teacher Fellows

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

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

Support for and Dissemination of Research-Based Resources and Tools

Network Connections

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

Network Connections sessions during Year Two were well received by participants. Evaluation findings indicated very high ratings across all sessions and meeting components. A number of participants

indicated that gaining exposure to current research findings and other resource information, along with the opportunity to meet as an institutional team, makes Network Connections a valuable resource to participating district teams.

Journal and *Coordi-net* Publications

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

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

Institutional Practices and Support Structures

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

Partnerships Across and Within IHEs

There has been some interaction among faculty across IHEs, particularly among team leaders and project directors, but individual faculty reported in interviews that they would have preferred to have more direct interaction with faculty at other IHEs. To varying degrees, math, science and education faculty reported the development of partnerships among faculty within an IHE, either between math and science faculty, or between education and math or science faculty. However, within an institution, the degrees of partnership varied from strong to virtually non-existent across these groups. In many cases, these partnerships existed prior to the MSP project and continued participation in MSP activities has

strengthened these connections. The strongest cases of partnership appear to exist in the IHEs where education faculty are members of the disciplinary department (for example, where math education faculty are members of the math department). In IHE interviews, discipline faculty members reported they are working with education faculty on courses, and in one case, collaborating to publish an article about the MSP.

Partnerships Between IHEs and K-12 Districts

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

Partnerships Between K-12 Districts and Between IUs

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

Math and Science Instructional Practices

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

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

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

Student Outcomes

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

Conclusions

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

Building capacity in schools that are most challenged

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

implementing districts. Questions for the MSP to consider include: Are different strategies and/or approaches needed for these districts? If so, what are they? Are the key leverage points different in these districts?

Clearly communicating intent and rationale

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

Linking the student teacher pipeline between K-12 and IHEs

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

Balancing competing or conflicting incentives between K-12 and IHE

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

each community be considered as models for the other? How can the MSP assist in encouraging sustained partnerships between IHE faculty and K-12 teachers where both partners benefit equally?

Recognizing and allowing for time constraints

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

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