Mathematics and Science Partnerships: Summary of Performance Period 2009 Annual Reports

Analytic and Technical Support for Mathematics and Science Partnerships

DRAFT

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Mathematics and Science Partnerships: Summary of Performance Period 2009 Annual Reports

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Executive Summary

Our nation's students are underachieving in mathematics and science compared to students in other industrialized nations. International tests of science and mathematics such as TIMSS and PISA (Schmidt, 1999; Gonzales et al., 2004; Lemke et al., 2004; Van de Werfhorst & Mijs, 2010) expose a need for improved education in mathematics and science. Research suggests that increased teacher content knowledge and teaching skills lead to improved student achievement (Cochran-Smith and Zeichner, 2005; Goldhaber and Brewer, 2000; Hanushek and Rivkin, 2010; Hill, Rowan, and Ball, 2005; Nye, Konstantopoulos, and Hedges, 2004; Timperley et al., 2007; Wenglinsky, 2002). Thus, education improvement efforts around the country are increasingly focused on the teacher as the most powerful agent of change for improving student learning.

As the limitations of short-term professional development opportunities for teachers have been recognized, there has been widespread interest in sustained university partnerships with local school districts to offer rich professional learning opportunities for teachers and administrators. The U.S. Department of Education's Mathematics and Science Partnership (MSP) Program funds 590 collaborative partnerships between high-need school districts and mathematics, science, and engineering departments at institutions of higher education (IHEs) for the purpose of providing intensive content-rich professional development to teachers and other educators, thus improving classroom instruction and ultimately student achievement in mathematics and science.

Implemented under the *No Child Left Behind Act of 2001, Title II, Part B*, MSP is a formula grant program to the states, with the size of individual state awards based on student population and poverty rates. The states then award the funding on a competitive basis to local partnerships. Federal support for MSP increased substantially from the program's inception in FY 2002—from $12.5 million to $100 million in FY 2003, when MSP became a state-administered formula grant program. Funding has since increased further, reaching a height of $179 million awarded to 590 local partnerships in FY 2009. In FY 2011, the statewide grants totaled over $175 million in funds.

Performance Period 2009 Mathematics and Science Partnerships

This report presents an overview of the MSP program during Performance Period 2009 (PP09),[1] including the characteristics of MSP projects and participants; the professional development content, models, and activities of the projects; and the MSP projects' evaluation designs and outcomes.

Amount of Funds

In Performance Period 2009 (PP09), federal MSP resources totaling $179 million were distributed to the 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.[2] State grants ranged from $890,416 to over $20 million, with an average of $3.2 million and a median of $1.9 million (see Appendix C). In turn, the states funded a total of 590 local MSP projects, with local grants ranging from $17,000 to $7.8 million, with a median project grant of $201,766, and mean of $289,948. As shown in Exhibit ES.1, most projects (86 percent) received $500,000 or less in funding. In addition to

[1] Performance Period 2009 (PP09) refers to the period between October 1, 2009 and September 30, 2010.

[2] The American Virgin Islands, Guam, the Northern Mariana Islands, and Samoa pool their MSP funds as part of their consolidated budget. They are not required to submit annual performance reports to the MSP Program, so their activities are not reflected in this report.

these federal funds, some local projects reported receiving supplemental funding from other federal and non-federal sources.

Exhibit ES.1: Project Budgets from State MSP Grants, Performance Period 2009

Project Budgets	Percent of Projects (N=588)
$100,000 or less	13%
$100,001 to $200,000	37
$200,001 to $500,000	36
$500,001 to $1,000,000	13
$1,000,001 or more	1
Source: Annual Performance Report item I.A.6 The non-response rate[3] was <1 percent in PP09.	

Participant Selection

In selecting schools and teachers to participate in the MSP program, MSP projects were encouraged to assess the professional development needs of individual schools and teachers. Most MSP projects (86 percent) in PP09 targeted individual teachers in their professional development interventions. The remaining 14 percent of projects indicated that their professional development models were designed to improve mathematics and/or science instruction throughout a school, or a set of schools.

Characteristics of Project Participants

Three thousand six hundred faculty members from institutions of higher education (IHEs) were involved with MSP projects in PP09, with an average of 6 IHE faculty members per project. Projects are required to establish direct interactions between participants and IHE faculty members in mathematics, the sciences, or engineering. Additionally, approximately two-thirds of the projects (66 percent) reported working with faculty members from education departments within IHEs.

Nearly 49,000 elementary, middle, and high school teachers, coaches, paraprofessionals, and administrators participated in MSP projects in PP09. The number of these participants served by individual MSP projects ranged widely from 6 to 1,423, with typical projects serving slightly over 40 participants. These participants, in turn, taught over 2.5 million students.[4]

Eighty-five percent of MSP participants were regular classroom teachers of core mathematics and/or science content. In order of prevalence, the remaining 15 percent of participants included special education teachers, school administrators, ELL teachers, gifted and talented teachers, math coaches, paraprofessionals, and science coaches.

School Levels

MSP projects are free to select the grades or school levels in which they provide professional development. In PP09, nearly four-fifths of projects (78 percent) targeted multiple school levels (i.e.,

[3] Throughout this report, all non-response rates are calculated out of the total number of projects that should have answered the APR question.

[4] Students may be included twice in this count, once as mathematics students and once as science students.

some combination of elementary, middle, and/or high school); 44 percent served participants from all three school levels. Among the participants of MSP activities, 50 percent were employed at the elementary school level, 27 percent were at the middle school level, and the remaining 23 percent were at the high school level.

Professional Development Content, Models, and Activities

Professional Development Content

In PP09, nearly 31 percent of MSP projects provided professional development in both mathematics and science; 39 percent provided professional development in mathematics only; and 30 percent of projects provided professional development in science only.

Most MSP projects addressed multiple content areas and topics, both within and across disciplines. Across school levels, scientific inquiry was the most frequently addressed science topic (92 to 95 percent of projects that addressed science), and chemistry was the least frequently addressed science topic (45 to 52 percent). In mathematics, problem solving was among the most frequently addressed content areas (84 to 88 percent of projects that addressed mathematics), and calculus was the least frequently addressed topic (2 to 18 percent of projects that addressed mathematics).

Professional Development Models

As shown in Exhibit ES.2, nearly half of projects (48 percent) conducted summer institutes[5] with school-year follow-up activities. These projects reported offering a median of 96 hours of professional development. Just 3 percent of projects provided summer institutes only, with no follow-up. The remaining 49 percent of projects provided professional development activities that primarily took place during the academic year, generally with a smaller summer component. These projects reported offering a median of 80 hours of professional development.

Exhibit ES.2: Average Professional Development Hours, by Professional Development Model Type, Performance Period 2009

Professional Development Model	Percent of Projects (N=585)	Total Median Hours
Summer institute with follow-up	48%	96
Summer institute only	3	80
Focus on school-year activities[6]	49	80

Source: Annual Performance Report item V.A.1, V.B, V.B(i).1, V.B(ii).1
The non-response rate for each model was as follows:
Summer institutes only: 0 percent; Summer institutes with follow-up 15 percent; and Focus on school-year activities: 1 percent

[5] Summer institutes provide intensive learning experiences for a minimum of two weeks during the summer. Projects that included summer workshops that were less than 2 weeks were classified as projects with a focus on school-year activities.

[6] This category includes projects with summer workshops totaling less than 2 weeks.

Professional Development Activities

The professional development activities offered by MSP projects focus on increasing teachers' content knowledge in mathematics and/or the sciences and on enhancing their pedagogical skills. The most commonly reported model for delivering school-year activities was on-site professional development (70 percent of projects), followed by study groups (15 percent), content coursework at colleges or universities (11 percent), and on-line coursework/distance learning networks (3 percent).

MSP Evaluation Designs and Outcomes

Evaluation Designs

MSP projects reported the primary designs they used to assess program outcomes. Three percent reported using an experimental design in which teachers, classrooms, or schools were randomly assigned to a treatment or control group. Another 48 percent of projects reported using a quasi-experimental design with a matched or non-matched comparison group. The remaining projects used less rigorous evaluation designs, such as: single group design with pre- and post-tests (34 percent); qualitative or descriptive methods only (10 percent), or mixed quantitative and qualitative methods (5 percent).

A review of final-year projects was performed to determine the extent to which projects successfully conducted rigorous evaluations to yield findings that could be considered reliable and valid. As Exhibit ES.3 shows, the number of final-year projects implementing comparison group designs increased from 37 in PP07, to 49 in PP08, to 65 in PP09. Similarly, the number of projects with at least one evaluation passing all rubric criteria increased four-fold from PP07 to PP09. While part of this difference can be attributed to a change in the criteria used to assess final-year evaluations in PP09, a larger proportion of the change is due to more projects implementing more rigorous designs. The MSP Program has been educating its projects about rigorous evaluation designs by providing them with criteria for carrying out effective impact evaluations. This has led to an increasing number of projects attempting to implement rigorous designs and more projects implementing them successfully.

Exhibit ES.3: Number of Final-Year Projects that Implemented Comparison Group Designs and Met all Rubric Criteria, Performance Periods 2007–2009

Projects	PP07	PP08	PP09
Implemented comparison group designs	37	49	65
Included at least one evaluation that passed all rubric criteria	4	3	16

Teacher Content Knowledge Outcomes

As shown in Exhibit ES.4, 62 percent of teachers who were assessed in mathematics and 71 percent of teachers who were assessed in science showed statistically significant gains in their content knowledge.

Exhibit ES.4: Percent of Teachers with Significant Gains In Content Knowledge, Among Teachers with Pre-Post Content Assessments, Performance Period 2009

Content Area	Total number of teachers served	Percent of teachers with content assessments	Percent of assessed teachers with significant gains
Mathematics	40,680	33%	62%
Science	23,310	47	71

Source: Annual Performance Report items VIII.A. 1, 2, 3, 4, 5, 6
Individual teachers who received professional development in both mathematics and science may be included in the number of both science and math teachers.

The most frequently reported assessments of teacher content knowledge in mathematics were nationally normed/standardized tests (63 percent of projects). Projects that did not use nationally normed or standardized content assessments often developed their own assessments for their MSP projects. Approximately one-third (34 percent) used locally developed tests to assess teacher gains in mathematics content knowledge. In science, the most frequently used instruments were locally developed tests (49 percent of projects), followed by standardized instruments (45 percent).

Student Achievement Outcomes

As shown in Exhibit ES.5, among the 51 percent of students with assessment data in mathematics, nearly two-thirds (64 percent) scored at the proficient level or above. Similarly, among the 33 percent of students with assessment data in science, 63 percent scored at the proficient level or above. These levels represent substantial increases from previous years in the proportion of students with assessment data scoring at the proficient level or above both in mathematics and in science.

Substantial Increases in Proportion of Students Scoring at Proficient or Above
In PP09, in both mathematics and science, nearly two-thirds of students scored at the proficient level or above, compared to fewer than half in PP07.

Exhibit ES.5: Percent of Students Scoring at Proficient Level or Above, Among Students Taught by MSP Teachers And Assessed In Each Content Area, Performance Period 2009

Content Area	Total Number of Students Taught by MSP Teachers	Percent of Students with Assessment Data	Percent of Assessed Students at *Proficient* Level or Above
Mathematics	1,476,835	51%	64%
Science	1,157,168	33	63

Source: Annual Performance Report items VIII.B. 1, 2, 3, 4, 5, 6, 7, 8

In PP09, almost all MSP projects (92 percent) that measured student achievement in mathematics used state assessments; however, in science, only half of projects (50 percent) that measured student achievement in science used state assessments. Projects also commonly reported utilizing locally developed tests (32 percent) and/or other types of tests (36 percent) to assess student achievement in science.

Conclusions

Unlike many teachers participating in more typical professional development programs, teachers who participate in the MSP program receive intensive and sustained content-rich professional development—from college and university faculty partners from science, mathematics, engineering, and education departments, as well as from other professionals--that integrates mathematics and science content with effective pedagogical strategies. Many of these teachers have the additional advantage of receiving ongoing support in the form of mentoring and coaching from faculty and master teachers as they begin to implement their new knowledge and practice in their classrooms.

In Performance Period 2009 (PP09), nearly 6,200 local educational agencies (LEAs), organizations, and institutions—involving 3,600 IHE faculty members—partnered to form 590 projects across the country. Projects served almost 49,000 educators[7] nationwide, with each educator receiving an average of 94 hours of professional development[8], thus enhancing the quality of classroom instruction for over 2.5 million students.

[7] Professional development was provided to a variety of teachers, coaches, paraprofessionals, and administrators across grades K through 12.

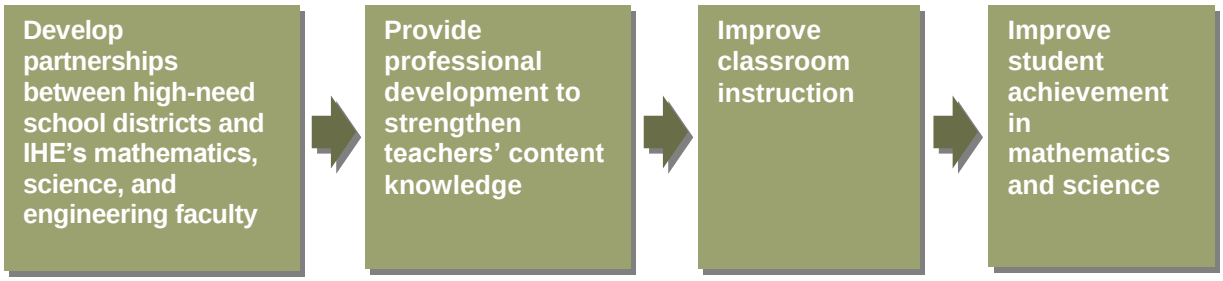
[8] The median hours of professional development offered across projects was 87 hours.

Chapter 1: Introduction

American students' underperform relative to students in other industrialized nations on international tests of science and mathematics such as TIMSS and PISA (Schmidt, 1999; Gonzales et al., 2004; Lemke et al., 2004; Van de Werfhorst and Mijs, 2010) which exposes a need for improved education in mathematics and science. Research suggests that increased teacher content knowledge and teaching skills lead to improved student achievement (Cochran-Smith and Zeichner, 2005; Goldhaber and Brewer, 2000; Hanushek and Rivkin, 2010; Hill, Rowan, and Ball, 2005; Nye, Konstantopoulos, and Hedges, 2004; Timperley et al., 2007; Wenglinsky, 2002). Thus, education improvement efforts around the country are increasingly focused on supporting teachers as the most powerful approach to improve student learning.

The limits of short-term professional development offerings for teachers have been documented, leading to a push for more sustained and focused professional learning for teachers. In efforts around the country to improve mathematics and science learning there has been interest in supporting partnerships between university faculty and local school districts in order to offer rich professional learning opportunities for teachers and administrators. The U.S. Department of Education's Mathematics and Science Partnership (MSP) Program funds nearly 600 of such collaborative partnerships between high-need school districts and mathematics, science, and engineering departments at institutions of higher education (IHEs) for the purpose of providing intensive content-rich professional development to teachers and thus improving classroom instruction and ultimately student achievement in mathematics and science (see Exhibit 1).

Exhibit 1: Conceptual Model of Mathematics and Science Partnerships Program



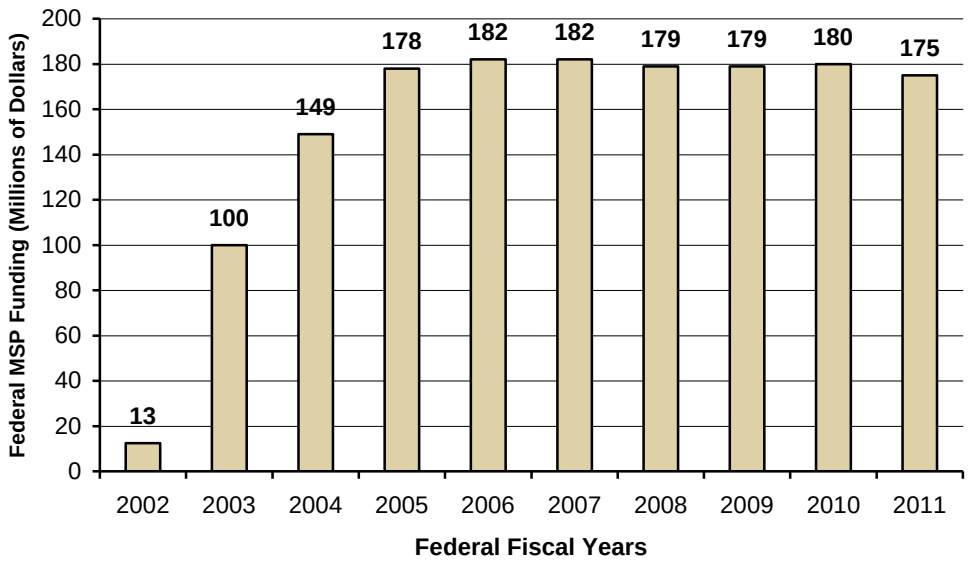
The Mathematics and Science Partnership Program

Implemented under the *No Child Left Behind Act of 2001, Title II, Part B*, the MSP program is strategically designed to improve the content and pedagogical knowledge of teachers and the academic performance of students in mathematics and science. The MSP program is a formula grant program to the states, with the size of individual state awards based on student population and poverty rates. The states then award grants on a competitive basis to local partnerships between high-need schools or school districts[9] and science, technology, engineering, and mathematics departments in institutions of higher education.

[9] The term "high-need" is not explicitly defined in the statute for the Mathematics and Science Partnership Program. Each state educational agency is responsible for conducting a needs assessment to determine the highest priority for these professional development funds and for defining high-need for its grant competition.

Exhibit 2 shows how federal support for the MSP program increased substantially from the program's inception in FY 2002 ($12.5 million) to FY 2003 ($100 million), when MSP became a state-administered formula grant program. Funding has since increased further, and since 2005, total funding for the program has hovered around $180 million annually. In FY 2009, the period described in this report, states awarded $179 million in funds to 590 local partnerships (projects) that collectively provided professional development services to an estimated total of over 48,000 teachers. Moreover, many projects trained teacher leaders, who then provided additional training to other teachers in their schools and districts.[10]

Exhibit 2: MSP Program Funding, Fiscal Years 2002–2009



Source: U.S. Department of Education state budget tables.

The administration of the MSP program involves an annual cycle of activities conducted at the federal, state, and local agency levels (see Exhibit 3). Each July, the Department of Education is charged with distributing MSP program funds to state education agencies for the upcoming fiscal year, based upon the number of children in the state 5 through 17 years old and living in families with incomes below the poverty line, In turn, states are required to run a competitive grant process to identify MSP projects and provide technical assistance to funded projects. Since FY 2003, all 50 states, the District of Columbia, and Puerto Rico have received MSP formula grants.[11]

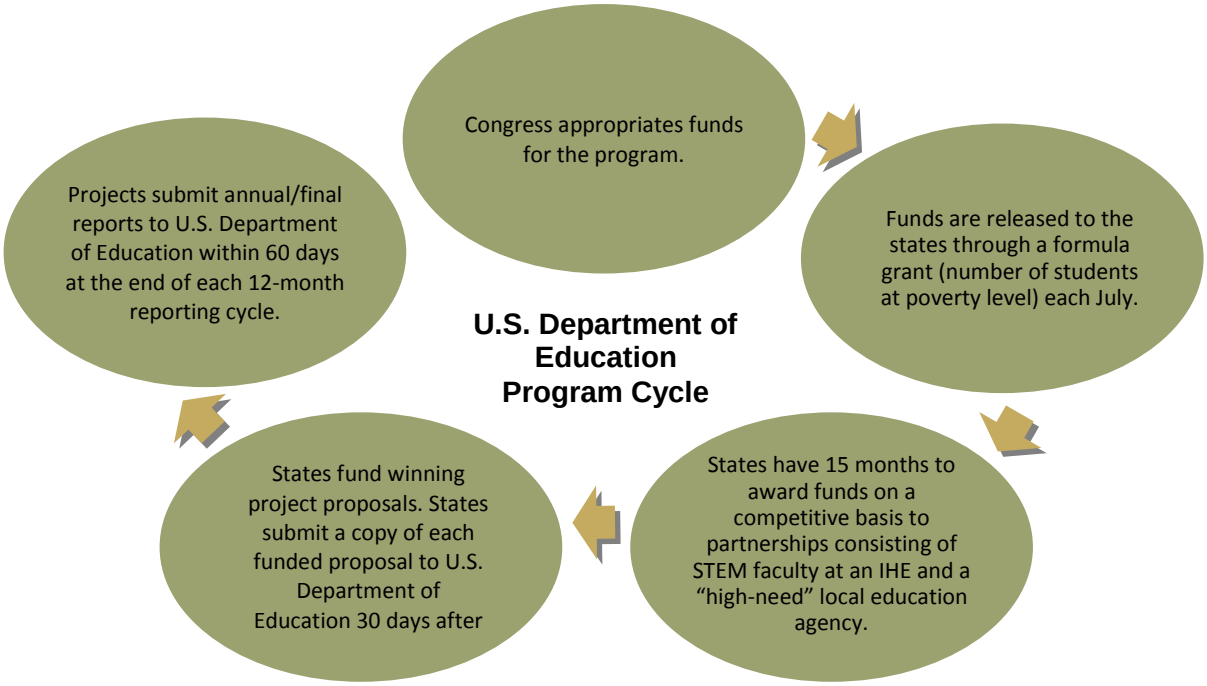
States have 15 months (through September 30 of the following year) to manage competitions and award their funds to projects (Exhibit 3). MSP sub-grants may be funded for up to three years. The law also requires all MSP projects report annually to the U.S. Department of Education. Projects

[10] Only teachers who received direct professional development through the MSP program are included in these numbers. Teachers who received training from teacher leaders trained through the MSP program are not included.

[11] The American Virgin Islands, Guam, Northern Mariana Islands, and Samoa pool their MSP funds as part of their consolidated budget.

provide descriptive information and report progress toward meeting their goals in an on-line reporting instrument.

Exhibit 3: MSP Grant and Funding Cycle



Projects respond to both open-ended and closed-ended questions, and are required to report the following types of information in their APRs:

- Roles and responsibilities of MSP partners,
- Characteristics of MSP participants,
- Professional development models and content,
- Program evaluation design, and
- Evaluation findings and evidence of outcomes.

Report Overview and Analytic Approach

This report presents a summary of the data for projects funded in Performance Period 2009 (PP09).[12] The findings presented in this report are primarily based on annual performance report (APR) data

[12] Performance Period 2009 (PP09) refers to the period between October 1, 2009 and September 30, 2010. PP09 projects are those for which the majority of months of activities described in the Annual Performance Report take place in the 2009 fiscal year, between October 1, 2009 and September 30, 2010.

submitted by all MSP projects by February 28, 2011.[13] Additionally, to examine trends in the MSP program over time, data from previous years are also included for some APR items. The report includes findings on a few selected APR items from previous periods beginning in PP04 when the first APRs were submitted. However, for most items, trends are only examined over the past three years. Since there is substantial turnover in the set of projects included in the analyses for each year, the findings should not be thought of as longitudinal. Thus, we would not necessarily expect to see growth over time, as new projects are continually added to the program and other projects are ending.

The analyses were guided by five research questions (Exhibit 4). The first four research questions are addressed through the use of simple descriptive statistics, such as means and percentages from closed-ended questions from the APR. Additionally, to help illustrate the types of professional development activities offered, and the impact of the projects on teachers, students, and faculty, the open-ended items were examined, and examples are provided throughout the report as well as in a chapter on special topics relevant to MSPs. The fifth research question is addressed through the review of final-year MSP projects that reported using an experimental or quasi-experimental comparison-group design to assess their MSP programs.

Exhibit 4: Research Questions that Guide Analyses

RQ1	How are MSP projects implemented?
RQ2	Do MSP projects report using rigorous designs, such as experimental or quasi-experimental designs, for their evaluations?
RQ3	Do teachers that participate in the MSP program increase their scores on assessments of content knowledge?
RQ4	Do students in classrooms of teachers that participate in the MSP program score at the proficient level or above in state assessments of mathematics or science?
RQ5	Do MSP projects using an experimental or quasi-experimental design for their evaluations conduct their evaluations successfully and do they yield scientifically valid results?

[13] These primarily included PP09 reports, but they also included some PP08 reports for which teacher and/or student data were not available in time to submit during the previous year.

Report Organization

The remainder of this report is organized into six chapters and three appendices, as follows:

Chapter 2: Characteristics of MSP Projects and Participants

Chapter 3: Professional Development Content, Models, and Activities

Chapter 4: MSP Evaluation Designs and Outcomes

Chapter 5: Special Topics in MSPs

Chapter 6: Highlights from MSP Projects with Rigorous Designs

Chapter 7: Summary and Conclusions

Appendix A: Review of Projects with Rigorous Designs

Appendix B: Criteria for Classifying Designs of MSP Evaluations

Appendix C: 2009 State MSP Appropriations

Chapters 2 and 3 describe how MSP projects were implemented. Chapter 4 describes the designs and outcomes projects reported. Chapter 5 presents special topics in MSPs, and Chapter 6 presents highlights from MSP projects that implemented rigorous evaluations. Finally, Chapter 7 provides a summary of the findings and makes concluding comments.

Appendix A provides a review of the final evaluation designs of projects that reported using experimental or quasi-experimental designs; Appendix B contains the criteria used for classifying rigorous evaluation designs; and Appendix C includes a table with the 2009 MSP state appropriations.

Chapter 2: Characteristics of MSP Projects and Participants

This chapter describes the general characteristics of the MSP projects. It provides information on the sources and amounts of funding used by MSP projects, the types and number of partners involved in MSP projects, the number of teachers and students served by MSP projects, the characteristics of those teachers, and the methods of participant selection.

Sources and Amounts of Funding

The MSP program is a formula grant program to the states, with the size of individual state awards based on student population and poverty rates. In PP09, federal MSP resources totaling $179 million were distributed through formula grants to all 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.[14] No state received less than one half of one percent of the total appropriation; MSP appropriations to individual states ranged from $890,416 to $20.0 million (see Appendix C).

With these funds, each state is responsible for administering a grant competition, in which grants are made to partnerships to improve teacher knowledge in mathematics and science. Individual MSP project budgets ranged from $17,000 to $7.8 million with an average funding level of $289,948 and a median of $201,765. As shown in Exhibit 5, over three-fourths of projects (77 to 86 percent) received $500,000 or less in funding between PP04 and PP09. In PP09, the percent of projects receiving between $500,001 and $1,000,000 dropped 4 percentage points from PP08 while the percent of projects in the $200,001 to $500,000 in the same period increased 6 percentage points. PP09 also continued the trend we have seen since PP04 of fewer projects receiving $1,000,001 or more, the highest levels of funding.

[14] The American Virgin Islands, Guam, the Northern Mariana Islands, and Samoa pool their MSP funds as part of their consolidated budget. They are not required to submit annual performance reports to the MSP Program, so their activities are not reflected in this report.

Exhibit 5: MSP Project Budgets from State MSP Grants, Performance Periods 2004–2009

Project Budgets	PP04 Percent of Projects (N=238)	PP05 Percent of Projects (N=341)	PP06 Percent of Projects (N=488)	PP07 Percent of Projects (N=574)	PP08 Percent of Projects (N=626)	PP09 Percent of Projects (N=588)
$100,000 or less	22%	20%	17%	9%	13%	13%
$100,001 to $200,000	23	29	37	43	38	37
$200,001 to $500,000	32	32	26	26	30	36
$500,001 to $1,000,000	17	14	15	18	17	13
$1,000,001 or more	6	5	5	4	2	1

Source: Annual Performance Report item I.A.6
The non-response rate[15] was 7 percent in PP04, 9 percent in PP05, 1 percent in PP06, <1 percent in PP07, 0 percent in PP08, and <1 percent in PP09.

Some MSP projects supplemented their federal MSP funds with funds from other federal and non-federal sources. In PP09, 19 percent of projects reported receiving funds from other sources. These additional funds ranged from $500 to $2.7 million.

Organization and Partnerships

Each MSP grant has a designated fiscal agent that serves as the lead organization for the project. The fiscal agent is primarily responsible for distributing MSP funds, but often organizes and manages the project's activities as well. The lead organization is typically either a local school district or an IHE, as seen in Exhibit 6. In PP04, school districts and IHEs held this responsibility in approximately equal percentages of projects (41 percent and 44 percent, respectively). However, between PP05 and PP08, at least half of all projects (between 50 and 56 percent) had local school districts serve as fiscal agents, while approximately one-third of projects (between 29 and 37 percent) had IHEs fulfill this role. PP09 continued this trend, but there has been a slight drop in the number of school districts listed as the lead organization dipping for the first time since PP05 below 50 percent. The remaining projects indicated that neither local school districts nor IHEs served as the lead organization. In PP09, other designated fiscal agents for the projects primarily included regional organizations (8 percent) and non-profit organizations (8 percent).

[15] Throughout this report, all non-response rates are calculated out of projects that provided professional development in that content area (i.e. projects that should have answered the APR question).

Exhibit 6: Types of Lead Organizations, Performance Periods 2004–2009

Type of Lead Organization	PP04 Percent of Projects (N=257)	PP05 Percent of Projects (N=375)	PP06 Percent of Projects (N=487)	PP07 Percent of Projects (N=575)	PP08 Percent of Projects (N=626)	PP09 Percent of Projects (N=590)
Local school district	41%	54%	53%	56%	50%	47%
Institution of higher education (IHE)	44	29	31	31	37	35
Non-profits, regional educational agencies, or other organizations	15	17	16	13	13	18

Source: Annual Performance Report item I.B.3
The non-response rate was 0 percent in PP04, 0 percent in PP05, 1 percent in PP06, 0 percent in PP07, 0 percent in PP08, and 0 percent in PP09.

The MSP program establishes local partnerships that include: 1) a science[16], technology, engineering and/or mathematics department of an institution of higher education (IHE) and 2) a high-need school district. However, MSP projects may incorporate other types of partners such as: education departments from IHEs; additional local education agencies including public charter schools, public or private elementary or secondary schools and school consortia; and businesses and non-profit or for-profit organizations that have a proven capacity to effectively improve the knowledge of mathematics and science teachers. MSP projects reporting in PP09 had an average of 10 partner organizations, with the number of partners ranging from 1 to 291.

In PP09, 3,600 IHE faculty members, working in a variety of disciplines, were involved with MSP projects. As shown in Exhibit 7, over half of all projects included faculty from mathematics (64 percent) and science (57 percent) departments, and 10 percent of projects included faculty from engineering departments. Additionally, nearly two-thirds of the projects (66 percent) reported working with faculty members from education departments, and 18 percent of projects included faculty from "other" departments such as psychology, computational science, and health. Others reported those associated with IHEs in a capacity other than teaching faculty, such as deans, administrators, district services, K-12 outreach staff, and consultants.

[16] Computer science is included with science departments.

Exhibit 7: Disciplinary Affiliation of IHE Faculty Participating in MSP, Performance Period 2009

Discipline	Percent of Projects (N=589)	Average Number per Project	Total Number Participating in MSP (Sum=3,598)
Science[1]	57%	3	1,098
Mathematics	64	3	1,037
Engineering	10	2	155
Education	66	3	1,129
Other	18	2	179

Source: Annual Performance Report items IV.A.1- 5
Percents total more than 100 percent because respondents could check more than one category.
The non-response rate was <1 percent.

[1]Computer science is included together with science.

MSP projects classified their stage of implementation into one of three stages: (1) *new* defined as conducting start-up tasks such as planning activities, formalizing partnerships, and implementing the professional development model for the first time; (2) *developing* defined as revising, enhancing, or continuing to develop their professional development model; and (3) *fully developed* defined as all components of a project's planned model were fully operational. Exhibit 8 shows that in PP09, more projects reported being fully developed or developing than new (47 percent, 36 percent, and 17 percent of projects respectively). This trend is in keeping with PP08, with a continuing increase in the proportion of projects that consider their implementation to be fully developed.

Exhibit 8: Projects' Stage of Implementation, Performance Periods 2007–2009

Stage of Implementation	PP07 Percent of Projects (N=573)	PP08 Percent of Projects (N=626)	PP09 Percent of Projects (N=588)
Stage 1: New	23%	15%	17%
Stage 2: Developing	35	40	36
Stage 3: Fully Developed	42	45	47

Source: Annual Performance Report item VII.C
The non-response rate was <1 percent in PP07, 0 percent in PP08, and <1 percent in PP09.

Number of Participants Served by MSP

The central purpose of the MSP program is to provide professional development to teachers in order to increase their mathematics and/or science content knowledge and their pedagogical skills. The underlying logic is that with deeper knowledge of the subject matter and understanding of effective instructional strategies, teachers will be better able to impact their students' achievement in mathematics and science. To accomplish this goal, MSP projects work with a variety of teachers, across grades K through 12. Additionally, the program aims to increase the support structures in place

for these teachers by training teacher leaders, coaches, and paraprofessionals, and by promoting the instructional leadership of administrators.

MSP projects reported serving nearly 49,000 participants in PP09, including elementary, middle, and high school teachers, coaches, paraprofessionals, and administrators (Exhibit 9).[17] The median number of participants served per MSP project decreased from 43 to 42, leveling from a high in PP07 (see Exhibit 9).[18] The number of participants reported by individual projects varied widely, ranging from a minimum of 6 participants to a maximum of 1,423. Nearly all projects (92 percent) worked with 200 participants or fewer. Well over half of the projects (62 percent) reported serving 50 or fewer participants in PP09; one-fifth (20 percent) reported serving between 50 and 100 participants; and the remaining projects (18 percent) reported serving more than 100 participants.

Exhibit 9: Distribution and Statistics Regarding Total Number of Participants Served by MSP Projects, Performance Periods 2007–2009

Number of Participants Served	PP07 (N=551)	PP08 (N=595)	PP09 (N=585)
Total number served by MSP projects	59,969	57,639	48,950
Median number served per project	54	43	42
Minimum number served per project	2	4	6
Maximum number served per project	1,540	3,944	1,423
25 or fewer	18%	21%	20%
26-50	30	36	42
51-100	26	22	20
101-200	13	11	10
201 or more	13	10	8

Source: Annual Performance Report items IV.C, IV.G.1
The non-response rate was 4 percent in PP07, 5 percent in PP08, and <1 percent in PP09.

[17] Thirty-one projects did not report the number of participants served.

[18] The median of 43 means that half of reporting MSP projects served 43 or fewer participants, and half served more than 43 participants. The median is a more meaningful measure of the number of participants served by typical projects since the mean number of participants was heavily skewed by a few projects that reported serving more than 1,000 participants.

Methods of Selecting Participants

MSP projects design their interventions to target specific groups of participants within the K–12 education system. They target individual teachers from one or more schools or districts or whole schools in which most or all participating teachers are in one school or a group of schools. MSP projects are encouraged to identify and select schools and teachers for participation according to the level of need for professional development services in mathematics and science.

As shown in Exhibit 10, most MSP projects (86 percent) in PP09 targeted individual teachers in their professional development interventions. The remaining 14 percent of projects indicated that their professional development models were designed to improve mathematics and/or science instruction throughout a school, or a set of schools. Among projects that targeted schools, almost all reported serving public schools (98 percent), with only a few serving private, charter, or other types of schools (2 percent). 71 percent of these schools had a schoolwide Title I status; and 70 percent had over 40 percent of students who were receiving free or reduced price lunch. In addition, forty percent of these schools had not met adequate yearly progress (AYP) during the 12-month reporting period.

Exhibit 10: Primary Target for Intervention, Performance Period 2009

Primary Target	Percent of Projects (N=590)
Individual teacher	86%
Schools (one school, schools within a district, or schools across district lines)	14

Source: Annual Performance Report item IV.B.2
The non-response rate was 0 percent.

Just over two-thirds of projects (68 percent) indicated that the main goal of their MSP project was to improve individual teachers' content knowledge, while just 3 percent had the main goal of training teacher leaders who would in turn train other teachers (Exhibit 11). Twenty-seven percent of projects reported that both goals were equally important, indicating that most projects who train teacher leaders also train individual teachers.

Exhibit 11: Main Goal of MSP Project, Performance Period 2009

Main Goal	Percent of Projects (N=590)
Improving teachers' content knowledge	68%
Training teacher leaders	3
Both	27
Other	2

Source: Annual Performance Report item IV.B.1
The non-response rate was 0 percent.

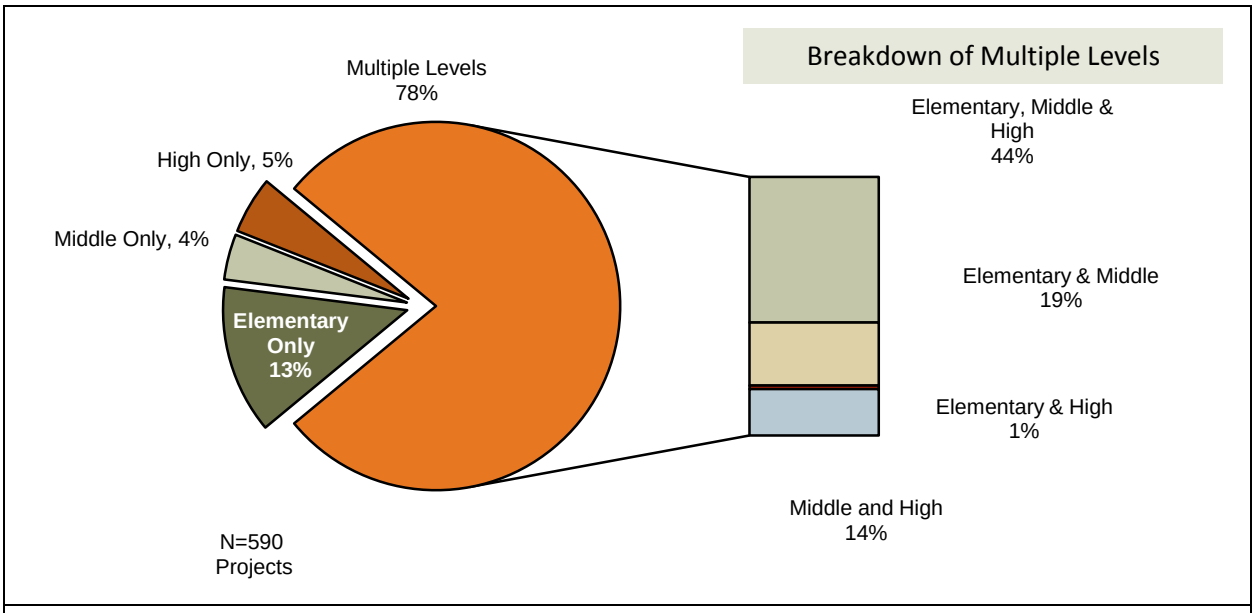
School Levels and Types of Participants Served

MSP projects are structured to address the professional development needs of educators at varying levels of the K–12 system. Projects may work with a group of participants drawn from a single school level (elementary, middle, or high school), participants from a combination of these school levels, or participants from the entire K–12 spectrum. Overall, in PP09, 78 percent of projects worked with participants from multiple school levels, while 22 percent of projects targeted a single school level.

As shown in Exhibit 12, 13 percent of all MSP projects in PP09 targeted the elementary school level only, 4 percent targeted the middle school level only, and 5 percent targeted the high school level only. The remaining 78 percent of projects targeted multiple school levels. Forty-four percent of projects targeted participants at all school levels; 19 percent targeted elementary and middle school participants; 14 percent targeted middle and high school; and 1 percent targeted elementary and high school. Although the majority of projects served multiple school levels, half of participants who participated in MSP projects (50 percent) were from elementary schools.

MSP participants were distributed across school levels in PP09 as follows: 50 percent at the elementary level, 27 percent at the middle school level, and 23 percent at the high school level. This represents a slight shift from the previous year of the proportion of teachers served from elementary and middle school to high school (in PP08, 53 percent of teachers served were at the elementary level, 28 percent were at the middle school level, and 19 percent were at the high school level).

Exhibit 12: School Levels of Participants Served, Performance Period 2009



Source: Annual Performance Report items IV.D, E, F, G
The non-response rate was 0 percent.

The MSP projects serve a variety of educators at all three school levels, including classroom teachers, administrators, and other school staff. Exhibit 14 examines the different types of educators participating in MSP projects and shows the percentages of total participants in each category across the MSP program as a whole.

The most commonly reported MSP participants, across all school levels, are "regular core content" teachers, defined as elementary school teachers who have regular classroom assignments, and middle

and high school teachers with mathematics, science, or technology assignments. Other types of MSP participants include:

Special education teachers—teachers who teach or support children with special learning needs;

School administrators—both principals and assistant principals;

Mathematics and science coaches—specialists who provide direct one-on-one coaching to students, and specialists who work with teachers to model instruction, conduct classroom observations, and provide personalized feedback and support;

Teachers of English language learners (ELL)—teachers who offer support to students whose primary language is a language other than English;

Gifted and talented /Advanced Placement (AP)/International Baccalaureate (IB) teachers—teachers who specialize in working with gifted students who need additional challenge; and

Paraprofessionals—staff, often referred to as *aides*, who are not licensed to teach, but who perform many educational duties, both individually with students and organizationally in the classroom.

Exhibit 13 shows the total proportion of each participant type served by school level. For example, special education teachers made up 5 percent of all elementary school level MSP participants. At each school level, at least 85 percent of teachers were regular core content teachers. The next two largest groups of MSP participants across school levels were special education teachers (between 4 and 7 percent) and school administrators (between 4 and 5 percent).

Exhibit 13: Percent of Teachers and Other School Staff Among All MSP Participants Served, by School Level, Performance Period 2009

Participant Type	Percent of Teachers and Other School Staff Served		
	Elementary School (K–5) (N=23,928)	Middle School (6–8) (N=12,735)	High School (9–12) (N=10,848)
Regular core content	85%	85%	86%
Special education teachers	5	7	4
School administrators	4	4	5
Math coaches	2	1	1
Science coaches	<1	<1	<1
ELL	2	1	1
Gifted and talented / AP-IB	1	1	3
Paraprofessionals	<1	<1	<1

Source: Annual Performance Report items IV.D, E, F, G
The non-response rate was 1 percent.

In total, MSP projects reported reaching over 2.5 million students in PP09. Exhibit 14 shows the total number of students at each school level who were taught by MSP participants, as well as the median,[19] minimum, and maximum number of students reached by MSP participants.

Exhibit 14: Total Number of Students Taught by Participants in MSP Projects, Performance Period 2009

Number of Students Taught	Elementary School (N=432)	Middle School (N=462)	High School (N=355)
Total number taught by MSP participants	714,021	1,009,379	818,392
Median number taught per project	675	1,020	1,050
Minimum number taught per project	18	12	6
Maximum number taught per project	35,575	43,050	70,605

Source: Annual Performance Report items IV.H
The non-response rate was 3 percent.
Projects could serve one or multiple school levels.

[19] These data, similar to the data on number of teachers, have been skewed by the presence of several unusually large projects. Therefore, the median is used to illustrate the number of students reached by a typical MSP project.

Chapter 3: Professional Development Content, Models, and Activities

This chapter describes the professional development activities offered in MSP projects. First, it describes the specific mathematics and science content of the MSP professional development. Then it describes the models of professional development offered (i.e., whether the professional development was primarily offered through summer institutes with follow-up or whether it focused on school-year activities) as well as the specific learning activities within those professional models.

Professional Development Content of MSP Projects

In their annual reports, projects indicated whether they provided mathematics and/or science content in their MSP professional development. They also identified the major topics within each discipline and the grade level of the teachers to whom each topic was taught. As shown in Exhibit 15, in PP09, 39 percent of projects focused on mathematics only, 30 percent focused on science only, and 31 percent focused on both mathematics and science.

Exhibit 15: Content Focus of Professional Development, Performance Periods 2007–2009

Content Focus	PP07 Percent of Projects (N=550)	PP08 Percent of Projects (N=619)	PP09 Percent of Projects (N=581)
Mathematics only	37%	37%	39%
Science only	30	31	30
Mathematics and science	33	32	31

Source: Annual Performance Report items VI.A.1, VI.B.1
The non-response rate was 4 percent in PP07, 1 percent in PP08 , and 1 percent in PP09.

MSP projects that provided professional development in both mathematics and science determined whether to integrate content delivery across the two subjects. Projects that used an integrated approach offered joint professional development opportunities on mathematics and science topics, while projects that did not integrate them taught mathematics and science courses separately either contemporaneously or consecutively.

Mathematics Content

Almost every MSP project provided professional development in multiple content areas, often focusing on topics relevant to the grade level of the participating teachers. Across MSP projects, these areas included: number and operations, algebra, geometry, measurement, probability and statistics, problem solving, reasoning and proof, calculus, and technology. Exhibit 16 disaggregates these content areas to show how often each topic was addressed across all projects; however, most projects covered more than one topic. In mathematics, problem solving was the most frequently addressed content areas across all school levels (84 to 88 percent of projects), and calculus was the least frequently addressed topic (2 to 18 percent).

At the elementary school level, over four-fifths of projects that involved math professional development addressed problem solving or number and operations as one of multiple content areas. Additionally, 55 to 65 percent of projects addressed measurement, algebra, or geometry; over half of

projects addressed technology or reasoning and proof; and nearly half of projects addressed probability and statistics.

At the middle school level, nearly all projects that involved math professional development addressed problem solving as one of their content areas; and over 70 percent of projects addressed algebra or number and operations. In addition, nearly two-thirds of projects addressed geometry or technology; and over half of projects addressed measurement, reasoning and proof, or probability and statistics.

At the high school level, over 80 percent of projects that involved math professional development addressed problem solving or algebra as one of their content areas; and nearly three-fourths of projects addressed technology. Additionally, 60 percent or more of projects addressed number and operations, geometry, or reasoning and proof; over half of projects addressed probability and statistics; and just under half of projects addressed measurement. Finally, approximately 20 percent of projects addressed calculus or other topics (18 percent and 22 percent, respectively).

Exhibit 16: Content Areas and Processes of Mathematics Professional Development Provided to Teachers, by School Level, Performance Period 2009

Mathematics Content and Processes	Elementary School Teachers Percent of Projects (N=301)	Middle School Teachers Percent of Projects (N=312)	High School Teachers Percent of Projects (N=238)
Problem solving	87%	88%	84%
Number and operations	81	72	62
Algebra	65	79	84
Geometry	55	63	61
Measurement	59	58	48
Probability and statistics	45	53	56
Reasoning and proof	51	58	60
Calculus	2	7	18
Technology	56	65	74
Other	15	17	22

Source: Annual Performance Report item VI.A.2

The total number of projects that provided professional development in mathematics content areas or processes in PP09 was 406. The non-response rate was 0 percent in PP09.

Percents total more than 100 percent because respondents could check more than one category. Projects could serve one or multiple school levels.

Science Content

As in mathematics, professional development in science was provided in topic areas relevant to the grade level of the participating teachers. Projects also focused on multiple content areas in and across disciplines. Across MSP projects, these areas included: scientific inquiry, physical science/physics, chemistry, life science/biology, earth science, and technology. As shown in Exhibit 17, scientific inquiry was the most commonly addressed topic among projects that addressed science across school levels (92 to 95 percent of projects), and chemistry was the least frequently addressed topic (45 to 52

percent). Most projects (68 to 73 percent) across school levels provided professional development in technology.

At the elementary school level, 95 percent of projects that involved science professional development addressed scientific inquiry. Additionally, over two-thirds of projects addressed earth science, physical science or technology; and just under 60 percent of projects addressed life science/biology. Nearly half of projects serving elementary school teachers provided professional development in chemistry.

At the middle school level, 95 percent of projects that involved science professional development addressed scientific inquiry. In addition, approximately three-fourths of projects addressed physical science/physics or technology, and over two-thirds of projects addressed earth science. At least half of projects serving middle school teachers provided professional development in chemistry or life science/biology.

At the high school level, 92 percent of projects that involved science professional development addressed scientific inquiry, nearly two-thirds of projects addressed physical science/physics or technology, and over 50 percent of projects addressed earth science, life science/biology or chemistry.

Exhibit 17: Content Areas and Processes of Science Professional Development Provided to Teachers, by School Level, Performance Period 2009

Science Content Areas and Processes	Elementary School Teachers Percent of Projects (N=261)	Middle School Teachers Percent of Projects (N=275)	High School Teachers Percent of Projects (N=193)
Scientific inquiry	95%	95%	92%
Physical science/Physics	68	75	73
Life science/Biology	59	57	56
Earth science	71	68	58
Chemistry	45	50	52
Technology	68	73	73
Other	26	29	28

Source: Annual Performance Report item VI.B.2

The total number of projects that provided professional development in science content areas or processes in PP09 was 354. The non-response rate was 0 percent.

Percents total more than 100 percent because respondents could check more than one category. Projects could serve one or multiple school levels.

Professional Development Models

MSP partnerships often focus their professional development activities around a summer institute, which is defined in MSP's governing legislature as a model of professional development that

provides multiple, intensive learning experiences over a minimum of a two-week period.[20] These learning experiences include deep exploration of mathematics and science content. Teachers then apply content they have learned to their teaching during the school year and receive follow-up support, such as additional content development sessions with faculty, coaching on classroom practices, and classroom observations. Although improving teacher content knowledge directly through a summer institute with in-school follow-up is the most common model of MSP professional development, some projects focus their efforts on school-year activities.

Projects with Summer Institutes

In PP09, approximately half of MSP projects (51 percent) conducted a summer institute, a decrease from 59 percent in PP08. According to the statute governing the MSP program, projects that use MSP funds to establish summer institutes are required to conduct activities for a period of not less than two weeks.

Projects that offer summer institutes are required to provide at least three or four days of follow-up activities during the academic year. Nearly all of the projects that offered summer institutes also conducted follow-up activities, with the aim of enhancing or extending the knowledge gained by participants over the summer. As shown in Exhibit 18, in PP09, 48 percent of projects conducted summer institutes with school year follow-up activities, while only 3 percent reported that they conducted summer institutes without any school year follow-up activities. Two descriptions of projects that provided summer institutes with follow-up are provided below.

> An MSP project in Oklahoma provided 72 K–12th grade math and science teachers with a two-week summer institute with follow-up activities. The elementary teachers attended one week of science and one week of math professional development; whereas the secondary teachers attended two weeks in their content area. The summer institute was aligned with research-based strategies and state and national standards. Throughout the school year, participants attended four six-hour Saturday follow-up sessions, during which they reviewed what was covered during the summer, learned about new topics and technologies, and reflected on their professional development. In addition, two follow-up sessions were conducted after the end of the school year, during which teachers focused on new ways to implement science, mathematics and technology concepts in their classrooms. (Colvin, 2010)

> A Georgia MSP project offered a two-week summer institute, 80 hours of intensive study and exploration of mathematics content and follow-up sessions to thirteen high school teachers, two accelerated math 8th grade teachers and three co-teachers. Summer institute sessions were structured so that half of each day was spent on content enhancement activities and the other half was spent on mathematics pedagogy. During the school year, teachers collaboratively planned and implemented lessons using the Lesson Study protocol. (Rogers, 2010)

[20] Projects that conduct summer work totaling less than two weeks are considered to be focused on school-year activities.

Exhibit 18: Types of Professional Development Models, Performance Period 2009

Professional Development Model	Percent of Projects (N=585)
Summer institute only	3%
Summer institute with follow-up activities	48
Focus on school-year activities	49

Source: Annual Performance Report item V.B
The non-response rate was <1 percent.

Projects Focusing on School-Year Activities

The remaining 49 percent of MSP projects in PP09 provided other types of professional development activities that primarily took place during the academic year. While some professional development may have taken place over the summer, these activities did not fit into the definition of "summer institute," which requires a minimum of two weeks of professional development. Instead, they were likely to include shorter workshops or conferences interspersed throughout the summer months as well as during the school year. Examples of other types of school year professional development activities offered by projects in this category include evening courses for credit, regular Saturday workshops, and semester-long internship sabbaticals for in-service teachers. Two examples of projects that focused on school-year activities, in addition to shorter summer sessions, are provided below.

> An MSP project in Colorado provided 30 Math K–12th grade teachers with a four-day summer workshop and a variety of other activities that took place during the school year. School-year activities consisted of five full days of a math academy in which the objective was to lay a strong foundation for algebra through the grades by increasing content and pedagogical knowledge; three full days of learning circles, and a three-day lesson study. Through the learning circles, teachers were able to integrate innovative problem-solving techniques into basic math content, conduct hands-on activities, and integrate inquiry-based learning into classroom design. The lesson study allowed teachers to design, teach, and refine, and reteach lessons incorporating new math content knowledge and pedagogy. (Wodlinger, 2010)
>
> A Nevada MSP project included a week-long summer workshop and six one-day follow-up sessions throughout the school year for 21 K–12th grade science teachers. Professional development focused on Earth and Space Science. Teachers were observed, coached, and mentored in the use of inquiry-based instruction, and during follow-up session discussions centered on modification and improvement of lessons. Participants were required to have two videotaped observations with a follow-up debriefing session. (Noland, 2010)

Hours of Professional Development Provided

Exhibit 19 shows the median number of hours of professional development[21] provided by model type. Among projects that conducted summer institutes only and projects that focused on school-year activities, a median of 80 hours of professional development were provided. Projects that conducted

[21] Projects that provided a very high or very low level of professional development skewed the average (mean), so we present the median.

summer institutes with follow-up activities provided a median of 96 hours. When the time spent during the summer was analyzed separately from school-year activities, projects spent a median of 60 hours during the summer institute, and a median of 32 hours on follow-up activities. The median hours for each model type remained the same as in PP08.

Exhibit 19: Median Hours of Professional Development, By Model Type, Performance Period 2009

Professional Development Model	Median Number of Hours
Summer institute only	80
Summer institute with follow-up activities:	96
Summer institute portion	*60*
Follow-up activities portion	*32*
Focus on school-year activities	80

Source: Annual Performance Report item V.A.1, V.B(i).1, V.B(ii).1
The non-response rate for each model was as follows:
Summer institutes only: 0 percent; Summer institutes with follow-up: 6 percent; and Focus on school-year activities: 0 percent.
Medians are calculated separately within each category. The medians for each type of follow-up do not sum to the median of the whole.

Professional Development Activities

In addition to providing intensive summer institutes, MSP projects offered a wide range of other professional development activities to participating teachers in PP09. Such activities were offered as follow-up to summer institutes, to supplement material and concepts learned in those institutes, or in lieu of summer institutes. In this section, we first present the prevalence of these additional activities; then we describe each type of professional development activity and provide examples from specific projects. The examples help to provide a sense of the broad variety of activities in which projects are engaged.

Exhibit 20 lists the primary activities that projects listed in addition to, or in lieu of, summer institutes. Overall, the most common form of school year professional development reported by MSP projects in PP09 was on-site professional development, which often takes place at or near the teachers' schools. This category includes activities such as recurring workshops, coaching, and mentoring, and was reported by 70 percent of projects that offered school-year activities. The next most common form of academic year professional development reported was study groups, such as professional learning communities or lesson study (15 percent). Other reported activities include coursework at universities (11 percent) and on-line course work/distance learning networks (3 percent). Finally, 1 percent of projects reported that they offered professional development activities that did not fall into one of the previously mentioned categories.

Exhibit 20: Primary Form of Professional Development Activities Provided by Projects, Other Than Summer Institutes, Performance Period 2009

Primary Focus of Professional Development Activities	Percent of Projects (N=562)
On-site activities during academic year	70%
Study groups	15
University courses	11
On-line course work / distance learning networks	3
Other activities	1
Source: Annual Performance Report items V.B.(ii), V.B.(iii) The non-response rate was 2 percent.	

The following sections describe each of the professional development activities in more detail and provide specific examples of how individual projects reported implementing these activities.

On-site Activities during Academic Year

As noted above, over two-thirds of all MSP projects (70 percent) reported that they engaged in on-site professional development activities during the academic year. Most of these projects also held 2-week summer institutes, or shorter summer workshops. Examples of these on-site activities include professional development in mathematics and science content for teachers, exploration of math and science education content standards, curriculum mapping, lesson and curriculum development, classroom modeling and demonstration, classroom observation with feedback, and inquiry activities.

Depending on the project and the activity, these sessions were conducted either with groups of teachers within or across grade levels, or one-on-one between individual teachers and mentors or coaches. Examples of the types of mentors or coaches reported by various projects include fellow teachers, district staff members, IHE faculty, graduate students, and professional development providers. Mentors and coaches can provide direct one-on-one coaching or work with teachers to model instruction, plan lessons, conduct classroom observations, and provide personalized feedback and support. Following are two examples of projects that employed mentoring.

> One MSP project in Pennsylvania provided professional development to twelve districts and a local diocese to improve teachers' content knowledge and instruction in science. In addition to the summer institute, nine follow-up workshops were offered during the school year. One two-day culminating event coordinated by the teacher mentors was held in the summer. Visits to the schools from university faculty and contacts with teacher mentors assisted the teachers in implementing the new content knowledge, new technologies, and new strategies into their classroom practices. Mentors assisted teachers as they moved from traditional science instruction to science as inquiry. (Shipley, 2010)
>
> An Idaho MSP project offered a one-week summer workshop that built teachers' knowledge of science content, inquiry-based instruction, assessment, and strategies for integrating science and literacy by actively engaging teachers in activities that modeled the use of science notebooks. Three day-long follow-up workshops during the school year provided support for on-going reflection on teaching and learning and the development of a learning community among teachers through the sharing of teaching and the examination of student

> work. Also, during the school year teachers were further assisted in translating new knowledge into practice through classroom-based mentoring by scientists, science educators, and mentor teachers. Finally, a project website facilitated communication and the sharing of resources between teacher, mentors, and project staff. (Kern, 2010)

Study Groups

Fifteen percent of the projects reported that their primary form of professional development during the academic year was study groups. Teacher study groups, which are sometimes structured as professional learning communities (PLCs), provide opportunities for ongoing collaboration with colleagues. Some projects reported that teachers in these groups shared lesson plans and reflected on both their content knowledge and classroom practice. Teachers might work with same-grade peers to better understand math and science education content standards, or participate in vertical teaming where they work with colleagues at consecutive grade levels to better understand the learning progression embodied in the standards and/or the curriculum. Other teacher groups engaged in lesson study, a process in which teachers jointly plan, observe, analyze, and refine actual classroom lessons. For more information and examples, please refer to Chapter 5, which highlights several special topics among MSPs, including PLC work.

Content Course Work at a College or University

With the goal of enhancing teachers' content knowledge, 11 percent of projects reported courses provided by a local college or university as their major form of professional development, other than summer institutes. The courses were often intensive and condensed into a period of two to three full-time weeks in the summer, or were held in the evenings or on weekends during the school year. In some cases, teachers earned undergraduate or graduate credit, and completing the courses helped teachers meet requirements for certification or highly qualified status.[22] Below are descriptions from two projects that provided teachers the opportunity to attend university courses and earn graduate credits.

> One MSP project in Kentucky provided two, three-week summer institutes focusing on standards-based mathematical content and instructional strategies. Institute content was offered via graduate-level courses, which teachers could apply toward master's degrees or advanced certification. The courses were team-taught by mathematics faculty, education faculty, and instructional coaches and integrated mathematics content and high quality teaching and learning instructional practices. As part of their course requirements, all teachers developed detailed lesson plans and plans for cooperatively implementing and assessing the lesson. (Hodgson, 2010)

> A North Dakota MSP project consisted of four, two-week summer courses and one eight-week summer course. The courses were in the areas of biology, geology, chemistry, physics, and an integrated summer course. Participants in project courses included elementary, middle school, and secondary science teachers. Through these courses, all participating teachers learned a variety of science content material from faculty through discussion and hands-on activities, and then were guided in developing specific lessons and adapting their instructional strategies for implementing what they have learned in their own classrooms. All courses focused on content knowledge,

[22] A "highly qualified" teacher must 1) hold a bachelor's degree; 2) have a full state certification or license; and 3) have demonstrated subject matter competence in each of the subject area(s) taught.

> principles of effective instruction, connection to state science content and achievement standards, and methods known to maximize student science learning. (Crackel, 2010)

On-Line Coursework/Distance Learning Networks

In order to provide teachers with convenient access to content materials, some MSP projects offered on-line courses or course modules that teachers could access on demand during the summer or school year and distance learning networks that help projects reach out to geographically isolated teachers. Three percent of projects reported this as their primary form of professional development, in addition to summer institutes.

An advantage of on-line programs is that they allow expanded access to professional development for teachers in rural areas and those who need the scheduling flexibility. Like other content activities offered by MSP projects, on-line courses usually focus on mathematics or science content but might also address issues related to teaching and learning, curriculum development, assessment, or other topics. A project's on-line course might also utilize software applications that support on-line communities such as Blackboard or WebCT, to encourage collaboration and communication among participants and facilitators.

Whereas the main function of on-line coursework activities is content delivery, distance learning networks focus on increasing collaboration and support among participants and MSP facilitators. Teachers who would otherwise have had to travel long distances to meet with their counterparts or with university faculty were able to form communities and/or mentoring relationships through the use of email, message boards, phone contact, videoconferencing, and other communication technologies. Examples of professional development offered by distance learning networks include mentoring and coaching, lesson plan exchanges, on-line study group discussions, and blogging. For more information and examples of on-line coursework and distance learning, please refer to Chapter 5.

Other Activities

One percent of MSP projects reported other activities as their primary form of school-year professional development. The variation among these other activities demonstrates how projects accommodated the varied needs and circumstances of participating schools and teachers.

Some commonly cited "other activities" included various types of field experiences, which ranged from daylong field trips to laboratory workshops to long-term internships or field work. Some reported examples of sites for these field experiences include museums, factories, observatories, national parks, mountains, lakes, and laboratories. While some of these activities were limited to daylong visits, other projects reported that teachers took part in more in-depth experiential learning. Below are examples from two MSP projects that used field experiences to supplement teachers' learning.

> One MSP project in Texas focused on increasing content knowledge for elementary, middle, and high school science teachers in the geosciences, chemistry, and biology content fields. They utilized day-long workshops and field experiences as the professional development model. Workshops were primarily conducted by science specialists at the education service center using research-based instructional strategies. Field experiences were conducted by scientists in their respective field. These included: Buffalo Bayou Canoe Field Experience; Comparing the Geology of Earth, Mars, and the Moon; Human Physiology of Space Flight; and More Rocks in Your Head. Other activities that participants engaged in included: hands-on biology, chemistry, geology, and physical science labs. (Bell and Ingle, 2010)

A Wyoming MSP project offered workshops, a variety of hands-on experiments and field trips complemented by lectures from university faculty as part of their professional development. Introductions to different fields of engineering complemented and preceded hands-on experiments and field trips to industrial and research facilities. These activities exposed participants to the opportunities and creativity found in engineering and to the significance of engineering in today's society. Research assistants helped participants complete the experiments, many of which were made available to participants for use in their classrooms. Excursions included trips to nearby wind farms, the National Renewable Energy Laboratory in Golden Colorado, and the Missouri Basin Power Project near Wheatland, Wyoming. (Ula, 2010)

Chapter 4: MSP Evaluation Designs and Outcomes

This chapter describes the types of evaluators and evaluation designs used by MSP projects, the measures used in evaluations, and teacher and student outcomes, which are used to assess the effectiveness of the MSP interventions.

Evaluation Designs

Every MSP project is required to design and implement an evaluation and accountability plan that allows for a rigorous assessment of its effectiveness. Projects are required to report on two aspects of their evaluation findings: 1) gains in teacher content knowledge based on pre- and post-testing; and 2) proficiency levels on state-level assessments of students of teachers who received professional development.

MSP projects reported conducting various different types of evaluations. As seen in Exhibit 21, approximately two-thirds of projects (68 percent) reported using an external evaluator in PP09. Using external evaluators – specialized staff from outside the partnership who are trained to conduct evaluations – allowed these projects to independently evaluate their work, and to receive help from these specialists in implementing the most rigorous designs feasible. Forty-four percent of projects conducted their own evaluations through their partnership staff, such as a school system's research office or a university research department. In addition, seventeen percent of projects reported that they received support from their state to participate in a statewide evaluation, placing their project in context with the rest of the MSP work being done in their state.

Exhibit 21: Types of Project Evaluators, Performance Period 2009

Type of Evaluator	Percent of Projects (N=588)
External evaluator	68%
MSP partnership organization staff	44
Statewide evaluation	17
Other	<1

Source: Annual Performance Report item VII.A
The non-response rate was <1 percent.
Percents total more than 100 percent because respondents could check more than one category.

Exhibit 22 presents the types of evaluation designs that projects reported using in PP09. Projects that used a combination of designs were instructed to report on the most rigorous design used in the project. Approximately half of projects (51 percent) reported using an experimental or quasi-experimental design. Three percent of projects reported that they implemented an experimental design, which is the most rigorous research design for testing the impact of an intervention, wherein schools, teachers, or students are randomly assigned to treatment or control groups. Nearly half of the projects reported using a quasi-experimental, or comparison group design to compare the effects of the MSP program on participating teachers and/or their students to non-participating teachers and/or students. Specifically, 28 percent of projects used a matched comparison group design, which attempts to show causality by demonstrating equivalence between groups at baseline or adjusting for any initial differences between groups, and 20 percent of projects reported using a non-matched

comparison group. Projects used a variety of measures to conduct pre- and post-tests of teacher content knowledge and tested the results for statistical significance.

The remaining 49 percent of projects reported using a less rigorous design type. Approximately one-third of projects (34 percent) reported using pre-tests and post-tests to assess the gains of the teachers served by MSP. Ten percent of projects reported using qualitative methods only, and 5 percent of projects reported using a mix of quantitative and qualitative methods.

Exhibit 22: Types of Evaluation Designs Used by Projects, Performance Period 2009

Evaluation Design	Percent of Projects (N=583)
Random assignment design (experimental)	3%
Quasi-experimental design	48
Matched comparison groups	*28*
Non-matched comparison groups	*20*
One-group design	34
Qualitative / descriptive design	10
Mixed methods	5

Source: Annual Performance Report item VII.B
The non-response rate was 1 percent.

Measures Used in Evaluations

MSP projects used a variety of instruments to assess teacher knowledge, student achievement, and/or the extent to which teachers applied the lessons from the MSP professional development to their classroom instruction. Below, we discuss the measures that projects used to assess these outcomes.

Measures of Teacher Knowledge

All projects were required to administer pre- and post-tests during the year(s) in which their teachers received intensive professional development. Projects used the MSP program's Teacher Content Knowledge macro to determine the number of teachers with statistically significance gains in teacher content knowledge. Exhibit 23 presents the types of assessments used to measure teachers' content knowledge in mathematics and in science and the types of assessments used to assess teachers' classroom practices.

The percentages of projects that reported using each assessment type followed similar patterns for mathematics and science. Standardized tests were the most frequently reported type of assessment utilized to assess teachers' content knowledge both in mathematics (63 percent) and in science (45 percent). This is an increase from PP08, when 57 percent of assessments used in mathematics and 40 percent of assessments used in science were standardized tests. Locally developed assessments that were not tested for validity and reliability were the next most frequently reported type of assessment for both mathematics (21 percent) and science (30 percent), followed by locally developed assessments with evidence of validity and reliability (13 percent of projects for mathematics and 19 percent for science). The remaining projects used self-report by teachers to assess their content knowledge, or other types of tests.

Exhibit 23: Types of Assessments Utilized to Assess Teacher Outcomes, Performance Period 2009

Assessment Type	Percent of Projects		
	Mathematics Content Knowledge (N=338)	Science Content Knowledge (N=284)	Classroom Practices and Beliefs (N=305)
Standardized test	63%	45%	40%
Local test, not valid & reliable	21	30	13
Local test, valid & reliable	13	19	14
Surveys or ratings	3	4	56
Other type of test	9	14	21

Source: Annual Performance Report item VII.D.1

Percents total more than 100 percent because respondents could check more than one category.

Only projects that provided professional development in each area and subsequently assessed those teachers responded to this question. The non-response rate for each content area was as follows: Mathematics content knowledge: 17 percent; Science content knowledge: 20 percent; and Classroom practices and beliefs: n/a.

Among projects that measure classroom practices and beliefs, over half of projects (56 percent) reported using surveys or ratings by teachers, students, or other MSP participants. Additionally, 40 percent of projects used a standardized test, and 27 percent of projects used a locally developed test. As seen in Exhibit 24, the most commonly reported assessments used to measure classroom practices and beliefs were the *Survey of Teacher Attitudes and Beliefs* (33 percent of projects), the *Reformed Teaching Observation Protocol* (*RTOP*) (16 percent), and the *Surveys of Enacted Curriculum* (15 percent).

Exhibit 24: Assessments Utilized to Assess Teachers in Classroom Practices and Beliefs, Performance Period 2009

Classroom Practices and Beliefs Assessment Measure	Percent of Projects Utilizing this Assessment (N=311)
Survey of Teacher Attitudes and Beliefs	33%
Reformed Teaching Observation Protocol (RTOP)	16
Surveys of Enacted Curriculum	15
Teacher Efficacy Belief Instrument	10
Inside the Classroom Observation Protocol	8
Other Assessment	61

Source: Annual Performance Report item VII.D

Percents total more than 100 percent because respondents could select more than one measure.

Only projects that provided professional development in this area and subsequently assessed those teachers responded to this question.

Exhibits 25 and 26 present the assessments projects used to measure teacher content knowledge in mathematics and science, respectively. Note that projects could have reported using more than one

assessment instrument and more than one assessment type. The two most commonly reported assessments used for assessing mathematical content knowledge were the *Learning Mathematics for Teaching* (*LMT*) (37 percent of projects) and the *Diagnostic Mathematics Assessments for Middle School Teachers* (12 percent). For measuring content knowledge in science, the two most commonly reported assessments were the *MOSART: Misconception Oriented Standards-Based Assessment* (16 percent) and the *Diagnostic Teacher Assessments in Mathematics and Science* (*DTAMS*) (13 percent).

Exhibit 25: Assessments Utilized to Assess Teachers in Mathematics, Performance Period 2009

Mathematics Assessment Measure	Percent of Projects Utilizing this Assessment (N=339)
Learning Mathematics for Teaching (LMT)	37%
Diagnostic Mathematics Assessments for Middle School Teachers	12
State Teacher Assessment	11
Knowledge of Algebra for Teaching	2
PRAXIS II	1
Other Assessment	50

Source: Annual Performance Report item VII.D
Percents total more than 100 percent because respondents could select more than one measure.
The non-response rate was 17 percent.
Only projects that provided professional development in this area and subsequently assessed those teachers responded to this question.

Exhibit 26: Assessments Utilized to Assess Teachers in Science, Performance Period 2009

Science Assessment Measure	Percent of Projects Utilizing this Assessment (N=287)
MOSART: Misconception Oriented Standards-Based Assessment	16%
Diagnostic Teacher Assessments in Mathematics and Science (DTAMS)	13
State Teacher Assessment	8
Assessing Teacher Learning about Science Teaching (ATLAST):	2
Force Concept Inventory	1
PRAXIS II	1
Other Assessment	67

Source: Annual Performance Report item VII.D
Percents total more than 100 percent because respondents could select more than one measure.
The non-response rate was 19 percent.
Only projects that provided professional development in this area and subsequently assessed those teachers responded to this question.

Assessment of Student Achievement

As seen in Exhibit 27, almost all of the MSP projects (92 percent) that measured student achievement in *mathematics* reported using standardized tests. However in *science*, only half of MSP projects (50 percent) that measured student achievement reported using standardized tests. This large difference in the use of standardized tests in mathematics and science could be due to the fact that statewide student assessments in science are often not administered in many grades, and even if there is grade-level alignment, the assessment often fails to include items covering the relevant content targeted by MSP. Projects that measured student achievement in science also commonly reported using locally developed tests (32 percent) and/or other types of tests (36 percent) to assess student achievement.

Exhibit 27: Types of Assessments Utilized to Assess Student Achievement, Performance Period 2009

Assessment Type	Percent of Projects	
	Mathematics (N=271)	Science (N=218)
Standardized test	92%	50%
Local test, valid & reliable	10	24
Local test, not valid & reliable	7	8
Self-report	1	1
Other type of test	6	36

Source: Annual Performance Report item VII.D.1
Percents total more than 100 percent because respondents could select more than one category.
The non-response rate for each content area was as follows: Mathematics: 33 percent; and Science: 38 percent.
Only projects that provided professional development in each area and subsequently assessed students responded to this question.

Measures of Classroom Instruction

MSP projects also measured the extent to which teachers applied lessons from their MSP professional development to their classroom instruction. As shown in Exhibit 28, four-fifths of projects (80 percent) in PP09 used questionnaires or other forms of self-reporting by teachers, and over two-thirds of projects engaged in direct classroom observation (68 percent) to assess participants' understanding and use of the content and strategies learned during MSP activities. The classroom observations can provide more objective, performance-based assessments of teacher classroom practices, while the questionnaires and other forms of self-reporting can provide valuable insights into teachers' opinions about how their MSP experience improved their teaching methods.

Projects reported other approaches to measuring classroom instruction as well, some of which were used in conjunction with classroom observation or questionnaires. Nearly one-fourth of projects (24 percent) reported reviewing journals in which participants tracked lesson plans and reflected on classroom practice. One-fifth of projects (20 percent) reported using "other" assessment methods, which included examining student assessment data and projects, as well as various other types of teacher self-reporting.

Exhibit 28: Methods of Evaluating the Application of MSP Professional Development to Classroom Instruction, Performance Period 2009

Measures	Percent of Projects (N=586)
Questionnaire/Self-report	80%
Classroom observation	68
Journals	24
Videotaping	14
Lesson plan analysis	9
Interviews/Focus groups	8
Blogs	7
Other	20

Source: Annual Performance Report item VII.E
Percents total more than 100 percent because respondents could check more than one category.
The non-response rate was <1 percent.

Evaluation Findings

As part of their evaluations, MSP projects are required to assess changes in teachers' content knowledge in mathematics and/or science during the years in which they receive intensive professional development. Projects reported the number of MSP teachers who significantly increased their content knowledge in mathematics and/or science topics on project pre- and post-assessments.

Teacher Outcomes

Exhibit 29 presents data on the number of teachers served in mathematics and science and the proportion who had pre- and post-assessment data available in each of the past three performance periods.[23] In mathematics, 40,680 teachers received professional development in PP09, and 33 percent of these teachers had assessment data available for the period. Although the proportion of teachers with assessment data decreased from PP08, it is more consistent with levels seen in earlier years. In science, the number of teachers receiving professional development decreased in PP09; however, the percent of teachers with assessment data remained stable.

Exhibit 29: Number of Teachers Served and Percent of Teachers Assessed, Performance Periods 2007–2009

Content Area	Total Number of Teachers Served			Percent of Courses with Content Assessments (Pre-Post)		
	PP07	PP08	PP09[1]	PP07	PP08	PP09
Mathematics	34,567	36,546	40,680	34%	43%	33%
Science	26,552	31,762	23,310	43	47	47

Source: Annual Performance Report items VIII.A. 1, 2, 4, 5

[1]Beginning in PP09, individual teachers who received multiple professional development courses may have been counted multiple times.

Exhibit 30 presents data for those teachers who were assessed for gains in content knowledge. Among the teachers assessed in PP09, 62 percent showed significant gains in mathematics content knowledge and 71 percent showed significant gains in science content knowledge. Furthermore, approximately half of these gains were found using standardized tests (63 percent of teachers in mathematics and 45 percent in science), that often are not directly aligned to the material being taught.

Exhibit 30: Percent of Teachers with Significant Gains In Content Knowledge, Among Teachers with Pre-Post Content Assessments, Performance Periods 2007–2009

Content Area	PP07	PP08	PP09
Mathematics	68%	67%	62%
Science	73	73	71

Source: Annual Performance Report items VIII.A. 2, 3, 5, 6

Individual teachers who received professional development in both mathematics and science may be double counted.

In PP09 the non-response rates were 12 percent in Mathematics and 10 percent in Science; in PP08 the non-response rates were 8 percent in Mathematics and 9 percent in Science; and in PP07 the non-response rates were 11 percent in Mathematics and 6 percent in Science.

Student Outcomes

Projects also reported the number of students served, assessed, and scoring at the proficient level or above in state assessments in both mathematics and science. As shown in Exhibit 31, in PP09 nearly 1.5 million students were taught by teachers who received professional development in mathematics,

[23] Projects are required to administer pre- and post-tests to each teacher who received professional development at least once during the course of the grant. MSP grants are typically three years long.

and over 1.1 million students were taught by teachers who received professional development in science.

Exhibit 31: Number of Students Served and Percent of Students Assessed, Performance Periods 2007–2009

Content Area	Total number of students taught by MSP teachers			Percent of students with content assessments		
	PP07	PP08	PP09	PP07	PP08	PP09
Mathematics	1,284,911	1,442,254	1,476,835	48%	43%	51%
Science	844,749	1,252,853	1,157,168	30	26	33
Source: Annual Performance Report items VIII.B. 1, 2, 5, 6						

State assessment data were reported for 51 percent of students in mathematics and for 33 percent of students in science, which both reflect increases from the previous year (see Exhibit 31). As noted above, the fact that state assessment data were available for approximately half of students in math and only one-third of students in science may be due to the misalignment that often exists between the subjects taught and the assessments available for students, particularly in science, where at the federal level it is only required that assessments be offered in three grade levels.

For the second year in a row, projects reported large increases from the previous years in the proportion of students with assessment data scoring at the proficient level or above in both mathematics and in science. In mathematics, the proportion of students scoring at the proficient level or above (64 percent) increased by 19 percentage points from PP07. In science, the proportion of students scoring at the proficient level or above (63 percent) increased by 14 percentage points from PP07.[24] Furthermore, the requirement that MSP projects are expected to include high-need/low-performing districts in their partnerships should also be considered when reviewing these numbers.

[24] Numbers were aggregated across all grade levels and schools.

Exhibit 32: Percent of Students Taught by MSP Teachers Scoring at Proficient Level or Above, Performance Periods 2007–2009

Content Area	Proficient Level or Above		
	PP07	PP08	PP09
Mathematics	45%	58%	64%
Science	49	58	63

Source: Annual Performance Report items VIII.B. 2, 3, 4, 6, 7, 8

In PP09 the non-response rates were 8 percent in Mathematics and 11 percent in Science; in PP08 the non-response rates were 17 in mathematics and 19 in science; and in PP07 the non-response rates were 14 in mathematics and 17 in science.

Chapter 5: Special Topics in MSPs

In this chapter, we focus on a few special topics that were highlighted by a number of MSP projects. This chapter first explores the particular challenges of rural areas, and the strategies MSPs use to mitigate these challenges. Then, it describes the use of Professional Learning Community (PLC) structure in professional development. Lastly, the chapter discusses the reported impacts of MSP work on STEM higher education faculty, and how MSPs make contributions at the state level. While these special topics are not directly applicable to all MSPs, they nonetheless provide valuable perspective on some of the nuances of MSP work.

MSP Projects Serving Rural Communities

Schooling in rural communities poses a unique set of challenges for MSP projects. Projects located in rural systems report limited resources stretched over vast areas, and a feeling of isolation. Some projects report that their rural schools have difficulty accessing new technologies, research findings, or content experts. Several rural MSPs noted that teachers in their areas take on multiple roles at both school and district levels, making it a challenge for them to focus on any one responsibility (such as targeted professional development in STEM content). Small teacher populations may also make it difficult for MSPs in rural areas to recruit enough teacher participants and to find replacements when turnover occurs. However, several MSP projects in rural areas have developed models tailored specifically to coping with these issues.

Mitigating Isolation

One obstacle to providing professional development to rural teachers is the inconvenience of travel time between sites, especially when funds are limited. Moreover, because schools in rural areas are often small, under-resourced, and far away from other schools, teachers may have the burden of increased responsibility, compounded by a smaller support network. To mitigate this problem, MSP projects employed various technologies to facilitate remote learning. Examples of these technologies include online coursework, emailing, listservs, blogging, social networking sites, and facilitated online discussions and forums. Online classes offered the convenience of scheduling flexibility.

Moreover, internet collaboration allowed participants to benefit professionally from sharing their knowledge and resources with like-minded peers, and could compensate for a lack of professional networks at the home site. For example, a project in Arkansas developed a portfolio of shared lesson plans by emailing across disparate sites (Trautwein, 2010). Below are two testimonies of how MSP partnerships provided collegial support networks to rural teachers who were otherwise isolated.

> An Indiana project reports that teachers across the county have networked, shared teaching strategies, and developed friendships. Some schools only have one classroom at each grade level, giving teachers little opportunity for support. Now, lead teachers from each district plan monthly professional development and coordinate math education across the county. All schools created curriculum guides to share across districts. They found that this collaboration was helping teachers feel less isolated. (Haywood, 2010)

> In response to "teacher silos," one Michigan project offered professional development that led to partnerships between teachers in different grade levels and content areas. Correspondence wrapped around lesson sharing, idea generation, problem-solving and technology usage. In the second year of the project, teachers worked in groups selected to merge their expertise and needs with the objective of forming more enriched lesson plans through the use of technology. (Hoffman, 2010)

Using Technology for Distance Learning

Many projects in rural communities report the use of videoconferencing and videotaping technology to create face-to-face interaction between sites. Participants took professional development courses and worked with mentors via iTV, Skype, or even cellphones. In addition, professional development providers used videotaping, podcasting, and other recording equipment to create exportable instructional modules. One project noted that producing instructional DVDs was one concrete way to involve STEM faculty (Meyer, 2010). While many of the sites faced glitches with videoconferencing technology, projects nonetheless saw potential to reduce cost and expand access to professional development. Below are two examples of how technology allowed teachers to participate in professional development and mentoring activities without needing to invest time and money in traveling long distances.

> Purchasing videoconferencing equipment enabled a statewide Alabama project to add lessons to their website to be shared with all teachers. They videotaped exemplary inquiry lessons to assist schools that are struggling with implementation, and provided examples of exemplary teachers for rural schools that cannot provide travel funds for their teachers. (Richardson, 2010)

> A partnership between six rural Arizona counties reported that iTV comprised a major platform for professional development. Each county developed as a team consisting of the county coordinator, teachers, the site-based leadership cadre member and the technology integration specialist. Site leaders communicated via cellphone and email, while coordinators and IT helped troubleshoot technology issues. Participant surveys documented that the level of content and the instructional approach were both challenging and beneficial overall. (O'Dell, 2010)

Providing Leaders, Facilitators, and Specialists

Though many rural MSP projects report satisfaction with using technology to augment distance learning, having an in-person specialist or leader could increase the tactic's effectiveness. Strong site-based leaders organized disparate participants and maintained communication between sites. MSP projects also employed coaches and other experts who could augment the content presented in online or video courses, particularly in the event of a technical issue. Other projects found it useful to provide technology specialists who could navigate site-based problems like malfunctioning equipment or lack of local technological knowledge. Although they did not eliminate implementation problems, leaders and specialists were a key factor in the success of distance learning, as seen in the following example:

> One Virginia project offered professional development with an IHE instructor at the central location and a math specialist at the video-conferencing location. When the video disconnected, the instructor and math specialist communicated via phone and kept the groups on task until the video was reconnected. The specialist could not only run the activities but answer questions about the mathematics as well. (Emerson-Stonnell, 2010)

Many rural MSP projects report employing and/or training site-based leaders, including teacher leaders, traveling professional development providers, and instructional coaches. In this way, a small group of experts could spread the professional development benefits to a much larger and more disparate group of teachers. Having experts travel to each site also allowed for a more individualized approach to professional development, which was especially important to teachers in rural areas, as many reported being responsible for a wider range of grade levels and subject areas. Traveling specialists were able to tailor professional development to each school's unique situation, as in the examples below.

> One New Mexico project gave districts the option of a part-time MC2 Math Field Specialist. A district "outsider" is not as effective a coach as someone who works with the district every day. However, this flexibility was critical to rural districts, where hiring a coach would not be financially possible and sustained professional development is expensive and often hard to come by, due to the geographical issues and small number of math teachers. (Bulger-Tamez, 2010)

> In Wyoming, because many schools have K–12 all in one building, one project found it impractical to limit the workshop by grade level or subject. They accepted teachers and para-professionals from all grades teaching any STEM discipline, and exposed them to a wide variety of topics. Then UW faculty and students worked with them individually to develop lessons for classroom use, and visited during the school year to implement the lesson plans. (Ula, 2010)

Expanded Opportunities for Rural Populations

When resources are limited at a single site, the partnership aspect of the MSP program becomes especially valuable. As a result of the funds and expertise MSPs provided, some rural sites were able to offer opportunities to their staff and students that they would not have been able to otherwise. For example, teachers at one rural school relied on their relationship with an IHE to introduce students to possibilities in higher education (Lanier, 2010). In another rural project, the co-PIs were able to present their work at national conferences, an opportunity that had never been available to them before (Combs, 2010). These and other successes of rural MSPs demonstrate the power of the collaborative partnership model.

STEM Professional Learning Communities

One common structure for MSP professional development activities was the formation of a professional learning community (PLC). At its most basic level, a PLC consists of a group of participants (generally teachers) who meet over an extended period of time in order to focus on improving one or more aspects of teaching and learning. PLCs serve as a forum for teachers to share and reflect on their experiences and participate in generative discussion with their colleagues. Within these guidelines, PLCs take different forms, and vary in the number and types of participants, frequency of meetings, focus, and activities. They may also critically examine their own work, focus on particular content or instructional standards and strands, or conduct theoretical and classroom-based research.

PLC Structure and Sustainability

There are several ways in which projects organize their PLCs, and each structure reflects a different goal. Many PLCs were comprised of teachers within one subject area, which can be targeted towards vertical alignment across grades within that subject, or might delve deeply into a particular content strand. Some PLCs integrated teachers across subjects, to gain an interdisciplinary approach to content or to address students that they teach in common. Still others reported a district-wide approach, which yielded diverse participant perspectives. Below, find an example of one project that facilitated both school- and district-level PLCs.

> One Indiana project established a district-wide PLC to support teacher leaders in creating building-level PLCs around math teaching strategies. Teacher leaders stated that the collaboration of so many individuals with different experiences was beneficial. Involving teachers from different grade levels with varying experience levels allowed them to adapt activities to different grades. They also evaluated data together, and could identify and consider multiple perspectives due to the group's diversity. (Garrity, 2010)

Some MSP projects focused on building sustainability and replication into their professional development model. The PLCs structure is conducive to this work, serving as a forum where the participants become comfortable with certain concepts or techniques, and then disseminate those to a wider audience at their home school or district. In some cases, teacher participants took the initiative to share their learning with colleagues outside of the project, either informally or formally through pre-existing PLCs and grade-level planning (Middleton, 2010). Other MSP projects used PLCs to generate tools, protocols, and guides to help non-MSP schools and districts implement PLCs or incorporate stronger curricula. One Washington PLC shared resources with the broader community:

> A non-participating middle school in a district with a participating school has begun using the PLC cycle from the project. Two non-participating districts have also asked for the tools and protocols to consider their use in their middle school PLCs. Also, students in a non-participating middle school have asked for the project's process to study environmental impact using math and science, and their school is moving forward to incorporate the curriculum. (Johnson, 2010)

Online Learning Communities

Some projects formed online PLCs or used technology to augment PLC work. Features such as forums and discussion boards, as well as blogging, chat rooms, and file sharing, added convenience for sharing resources or developing lesson plans. Some also used videoconferencing or programs like Moodle to conduct PLC meetings remotely. This way, participants could engage in productive conversations with others in spite of distance or scheduling constraints, and could store and build on each other's ideas. Here is one example of a project that used an online forum to accompany the work being done within and across its PLCs.

> One North Carolina project developed 19 school-based PLCs, which began in fall 2009 and met monthly through May 2010. A project wiki provided discussion space for participants across all PLCs to respond to their learning. There are 253 wiki members, and between October 2009 and June 2010, there were 18 discussion categories with threads, photos and videos. (Elder, 2010)

Using PLCs for Lesson Study

Of the MSP projects that reported using a PLC model, many identified lesson study as a professional development focus. Lesson study is a form of classroom practice-driven action research, in which a group of teachers co-research, plan, implement, reflect on, revise, and potentially re-implement a lesson. Though there are variations on how PLCs conducted their lesson study projects, all lesson study was characterized by a research-driven approach to collaborative lesson design. The PLC structure allows teachers to delve deeply into the research, data collection and observation, reflection, and redesign that lesson study requires. Because it focuses on refining a particular lesson, lesson study is more likely to occur in same-grade or same-subject PLCs. Below are two examples of STEM PLCs that implemented lesson study.

> Participants in one Maryland grant completed a lesson study cycle, which included collaborative lesson planning, lesson implementation, and group debriefing on the lesson's effectiveness. Teachers were supported by university faculty, who provided math content workshops and reviewed written and video-recorded lessons, and school-based math coaches, who assisted in collaborative lesson planning and reflection on lesson effectiveness. (Ennis, 2010)

> In one Ohio project, teachers formed grade-level teams to plan, implement, revise, and re-teach a lesson. Teachers selected a math topic targeted to address specific student needs, using state content standards and district pacing guides to identify the lesson's goals. With the help of IHE facilitators,

> teachers constructed learning hierarchies, explored instructional strategies such as Think-Pair-Share and Socratic questioning, and analyzed online video lessons, then used project-developed protocols for pre- and post-lesson discussions. (Appova, 2011)

Other Activities within PLCs

MSPs reported that their PLC structure also incorporated a range of other activities. PLCs invited STEM or STEM education experts to give talks about content and new research in the field. Participants also attended symposia, conferences, workshops, and field experiences to augment content knowledge. Other PLCs included coaches as members and facilitators to provide guidance for the teacher participants, most notably around technology integration, content, and current research in STEM. PLCs frequently worked to align instruction more effectively to district, state, or common core standards. Lastly, many PLCs provided time for teachers to analyze student artifacts and performance data and gather input from their peers.

In addition to content, PLCs addressed pedagogical issues pertaining to monitoring student thinking and designing more effective instruction. Commonly reported topics included strategies for inquiry-based learning, formative assessment, addressing student misconceptions, questioning, and scaffolding student understanding. Some PLCs wrote that the time afforded by the PLCs allowed them to delve deeply into these instructional nuances, which they otherwise would not have done. Participants also conducted peer observations with their colleagues to see how their work was applied in the classroom. Finally, PLCs served as support networks, in which members could bring particular issues from their classrooms for discussion and problem-solving with the rest of the group. Overall, PLCs allowed participants to devote time and attention to issues that do not always fit into the established school-day schedule.

Impacts on STEM Faculty

STEM and other IHE faculty often served as the "providers" in MSP partnerships, since they usually designed and delivered professional development, or coached K–12 teachers. However, in the spirit of the collaborative model, many MSP projects report that the IHE faculty also benefitted from their partnerships with LEAs. In working closely with LEAs, STEM faculty developed a new appreciation for classroom teachers' expertise and the importance of teaching science education. Faculty members learned about pedagogical strategies and K–12 education issues that had implications for their own teaching practice. Through these collaborations, faculty found new avenues to get involved at the K–12 level beyond their grant activities, thereby contributing to the sustainability of the partnership.

Changes in Faculty Attitudes and Teaching

Many projects report that STEM faculty gained new perspectives on teaching from their MSP work. In preparing their lessons for this new audience, STEM faculty often found that they needed to change their approach, and that classroom teachers had different needs than university students, specifically for translating the STEM content to a K–12 level. Faculty gained insights about the unique needs in K–12 classrooms and learned new practices to incorporate into their own teaching at the post-secondary level.

> At first the university science instructors in one Arizona project felt that "elementary school teaching" took too much time, and limited the amount of factual information that could be delivered in each session. Later, instructors reported that they had begun incorporating some of the more student-centered strategies into their college courses. (Gibbs, 2010)

> One STEM faculty in Montana indicated that the project opened his eyes to the deficiencies of science education in the elementary school and that this led him to focus on teaching fundamental concepts. (Miller, 2010)

Impacts on Institutes of Higher Education

Not only did STEM faculty find that their approaches to STEM teaching had changed within their own practice, but they also brought their new insights to their institutions. MSP partnerships created connections, not only between LEAs and IHEs, but also between departments within an IHE, leading to interdisciplinary collaborations and expanded opportunities at universities.

> An Illinois project reported that faculty created new courses and forged new collaborations. For example, a science teaching expert teamed up with a psychology of science/math education expert to offer a well-received course on the psychology of science and math learning. Another Illinois project reported that faculty from the chemistry department and the college of education developed a working relationship through which the chemistry faculty gained a deeper understanding of the value of chemical education. (Hug, 2010; Slavsky, 2010)

Extending the Partnership

MSP projects report a range of ways in which associated faculty were able to participate in activities outside the scope of the grant, extending the effects of the MSPs and creating more interaction between K–12 and higher education. For example, two partnerships in Ohio allowed faculty to interact not only with K–12 teachers, but also directly with their students. Five participating faculty were invited to judge projects at a middle school science fair for the first time in six years, while faculty at another university created a science field trip for middle school students that has been requested to continue annually beyond the life of the MSP project (White, 2011; White, 2010). In another project, an Arizona math professor decided to invest a substantial amount of time in working with high school teachers on mathematical modeling, even writing a grant for this purpose, despite never having worked with K–12 teachers before his MSP involvement (Toncheff, 2010).

A Case Study

One California project provided extensive data on the inextricable ways in which the students and teachers at *all* partner institutions enriched, and were enriched by, their colleagues. Professors reported changes to both their attitudes and practice, and the partnership resulted in IHE-level structural changes that impacted constituents outside the MSP partnership including IHE faculty, undergraduate students of both STEM and education, K–12 teachers, and K–12 students. The creation of a "model academy" approach to teacher preparation is expected to sustain and expand the effects of the MSP partnership after the end of grant activities (see inset, right).

The model academy at CSU - Chico has completely changed the way college students learn to teach science. The class is now required for liberal studies students and is taken by a significant number of science majors, some of whom have expressed interest in teaching science at the high school or college level. The class includes a reflective teaching component (a major goal for teachers in the MSP grant), and allows college students to work with children in a controlled setting.

By participating in lesson study analysis of the model lessons presented in the Hands-on Lab academy, IHE faculty have been able to develop a working relationship with area teachers. Plus, the model academy has the added benefit of introducing children to the local IHE. For many of these children the visit to the model academy may have been the first time they considered the possibility of going to college.

One STEM professor noted: "I have a greater appreciation for the work and time that elementary teachers spend in their preparation, their enthusiasm for learning, and their dedication to improving their methodology. I have always felt that there should be a means for the sharing of resources and ideas between college and K–12 educators to facilitate vertical articulation. This grant has provided an avenue for the development of effective classroom teaching strategies and lesson study."

Another STEM professor said: "Working with teachers has taught me that there must be mechanisms in our colleges to address differentiated learning... This has been the education in teaching I never got as a graduate student working toward teaching at the university level." (Ewart, 2010)

Impacts on States

While MSPs involve LEAs and IHEs, some projects report impacts beyond the scope of the grant activities. The central ways in which MSP projects reported making a statewide impact are by disseminating their products and findings within the state; helping interpret state standards and preparing teachers to implement them; contributing to state STEM initiatives; and devising courses that qualify for state certification credits.

Dissemination within State

MSP partnerships frequently share their products and findings on a statewide basis through a range of media and channels, including documents, web-based materials (sometimes on dedicated project websites), videos, state MSP meetings, regional MSP meetings, and other state and national conferences. Some shared products include professional development materials and lesson modules, as well as other resources to help partnerships plan, implement, and evaluate their MSP projects. One project disseminated a research lesson at a state conference:

> Teachers from one project enacted a research lesson at the 2010 Iowa Council of Teachers of Mathematics (ICTM) annual conference, involving (1) how people learn, (2) unpacking the intended math learning and repacking it into lesson plans, (3) live enactment of a lesson with

> students, (4) post-lesson discussion, and (5) refined the plans. Lesson study at the high school level is rare and the public lesson at the ICTM conference provided an opportunity for teachers not involved in the project to interact with project participants around the practices of studying math, planning instruction, reflecting on the artifacts of instruction and learning. (Fi, 2010)

An MSP in Texas shared its expertise at the state level and promoted further dissemination by other projects through journal trainings and by providing support to parents. They noted:

> "Our journal training has had not only an impact in our region, but also on a state level. Our math specialists delivered journal training to the TRC Math Collaborative project directors in September 2009 and to the CSCOPE State Conference participants in June 2010. We have also offered district support for parent night activities so parents can get content training and more effective helping their children with homework. The parent connection is a new impact that we hope to develop further and offer to a wide range of districts." (Ralston, 2010)

State Standards Efforts

Several MSP projects take on the work of helping interpret and prepare teachers to implement state standards, whether as an explicit project goal, or as an outgrowth of project work. In many cases, the role grows out of teachers' need for familiarity with the state standards and a shortage of other resources. Project materials that focus on state standards are easily transferrable among teachers around the state, which means that even teachers who did not participate in the project-based professional development can benefit from them.

One project set out to introduce teachers to new state standards and offer modules espousing best practices:

> PROMiSE developed materials to familiarize teachers with Florida's state standards and their implication for classroom instruction including the need for enhanced content knowledge… The goal of the modules is to provide teachers with a conceptual organization of the standards including the conceptual foundations of teaching for understanding, implications for instruction, and examples (e.g., video tapes, activities, project-developed online tools). (Kersaint, 2010)

Another project produced modules aligned with state standards, made available to teachers statewide on the project website:

> "Likely the most important broader impact … is the project website. Many science teacher resources are housed at this site; among these are the project participant-developed modules specifically aligned to Utah state core standards. These serve as a resource for all participants in the project as well as teachers throughout the state..." (Campbell, 2010)

Finally, a third project identified work with teachers on state standards as a future priority:

> "This summer we proposed a statewide teacher leadership project that has been very well received. At our kick-off event, thirty mathematics and literacy specialists attended. We believe that the need to interpret the Common Core State Standards has created a critical need for more work and that from this project, there will come an increased awareness of the importance of teacher leadership in these efforts." (Maxwell, 2011)

Project Staff Involved with State STEM Initiatives

The work of MSP partnerships occasionally qualifies project staff to contribute to state STEM initiatives—both through pre-existing programs, and through programs of their own design. Reports

described a range of activities, from defined work on a state initiative, to a structured program of project faculty-led meetings, to ad-hoc leadership on consistent teaching strategies through project networks. Two projects described how its products have enhanced an existing state math initiative:

> The Alabama Math, Science, and Technology Initiative (AMSTI) provides basic services to empower teachers to help students learn through doing math and science. The MSP funds allowed AMSTI to provide Summer Institute training as part of their statewide initiative. From the 2010-2011 project budgets, an estimated 4,676 days of professional development were provided to 779 math and science teachers. Additionally, across Alabama, MSP funds were used to employ 15 full time math and science specialist positions. The coaching and professional development supports provided by these personnel have helped schools to develop structures to sustain the lessons learned via Summer Institutes. In many schools, Professional Learning Teams and Lead Teacher structures help to ensure that the culture of the school continues to support teacher growth in math and science content and pedagogy. As schools build capacity to support math and science instruction, the need for specialist services will diminish. (Hollis & Howard, 2011)

> The DMT project has helped coordinate and develop aspects of the Idaho Math Initiative (IMI). The IMI is a statewide effort to improve students' learning and performance in mathematics, and to increase the number of students who take advanced math courses and seek employment in mathematically rigorous careers. Much of the IMI professional development and policy design is modeled after work conducted by DMT staff as part of this MSP grant. (Brendefur, 2010)

One project uses its broad scope to promote a statewide mathematics agenda:

> The project includes all education service agencies (ESAs) and reaches schools in every region. The two largest school districts in the state each support a math specialist working with teacher leaders. This model allows for statewide leadership to build at multiple levels of the system. Thus the project has the potential to impact elementary mathematics across the state – sending a common, consistent message about improving inquiry-based math teaching and providing multiple supports to reach this goal. (Mathiesen, 2010)

Project Coursework and State Certifications

Some projects described success they had developing courses that were approved by states to count toward teacher certifications. In one case, the credits accrued through MSP classes help teachers earn specialty certifications, making them more attractive to prospective schools and districts. In another case, a project was considering integrating courses that qualify for a new statewide instructional facilitator endorsement into a Master's program consisting of other content and research courses. Below, one project explains how its credits help teachers earn certifications, in turn helping districts that seek highly qualified teachers:

> The Nevada State Department of Education has accepted the NNSP as a legitimate source of content information because its consultants are qualified in their subject areas as UNR professors. The Department agreed to use credits acquired through the NNSP project to certify teachers in biology, earth science, and physical science. This has been a real asset for teachers and districts who struggle to hire highly qualified teachers. (Noland and McLean, 2010)

Another project considers integrating instructional facilitation courses into a content- and research-based Master's program:

> Though many Arkansas schools have literacy or math coaches, there are too few coaches for science. Project staff members led an effort to develop a way to provide coaches with appropriate credentials. Two IHEs will offer courses for the Instructional Facilitator endorsement. The project is exploring a Master's program with content and research courses for those who desire to increase their mathematics content knowledge in addition to the endorsement. (Addison, 2010)

While almost all MSP projects provide content-based professional development for STEM teachers, each grant designs a unique program that makes use of its strengths and addresses local needs. The experiences of these projects, provide perspective on the diversity of partnerships nationwide and may serve others looking to accomplish similar goals. Even among projects that implement a shared professional development format, professional learning communities, there is great variety in their focus, structure, and approach. Projects in rural areas have devised innovative solutions to the challenges they share. Some projects also report impacts beyond the scope of their grant activities, such as changes to the structure of the IHE or influence on STEM education activities at the state level. This information, gleaned from the qualitative text of the annual performance reports, complements the statistics presented in prior chapters, and offers a glimpse into the possibilities of the MSP model.

Chapter 6: Highlights from MSP Projects with Rigorous Designs

In this chapter, we provide highlights from the sixteen final-year MSP projects across nine states that included rigorous evaluation designs demonstrating the impact of their programs. By reviewing the interventions and findings of these successful evaluations, we have the potential to learn what aspects of professional development are associated with improvements in teacher content knowledge, teacher pedagogical content knowledge, student achievement, and/or teacher practices. Appendix A presents the review process and its findings and Appendix B includes a description of the criteria used to determine rigor of design.

Most of the passing projects included multiple evaluations of diverse outcomes within the same report. However, only those aspects of their research conducted to study potential *impacts* of MSP programs on teacher content knowledge, teacher pedagogical content knowledge, teacher practices, or student achievement in a rigorous manner are included in this chapter.[25]

For each project with a passing evaluation, we provide information about its background, goals, and professional development. The summaries of the projects' efforts and achievements that follow are based on information included in their evaluation reports, supplemented with information from Performance Period 2009 APRs. Exhibit 33 provides information about each passing MSP project. Below we provide a brief overview of the key findings.

Key Findings

Types of Professional Development Initiatives

- Two projects provided math and science professional development, 6 focused on science exclusively, 7 focused on math exclusively, and one project focused on engineering.
- Thirteen projects aligned their professional development to their state's math or science standards; 10 focused on inquiry-based strategies; 8 included a focus on technology; and 2 included a focus on science literacy.

Grade Levels Taught by Targeted Teachers

- Seven projects served elementary school teachers only, 3 were designed only for middle school teachers, and 4 projects worked with both elementary and middle school teachers.
- One project targeted high school teachers, and 1 project served teachers across all grade levels and also included 9 administrators

Professional Development Models and Activities

- The majority (14) of projects provided summer institutes (at least 60 hours or 2 weeks) or workshops (fewer than 60 hours) in addition to school-year activities; 2 focused on professional development during the school year.

[25] These projects may have also evaluated other outcomes, such as teacher efficacy, leadership capacity, and student engagement. However, because these outcomes are not as closely linked with the goals of the MSP program, they are not included in our review.

- All projects conducted follow-up work during the school year.
- Five projects included lesson study in their professional development, and 7 complemented their school-year trainings with professional learning communities or teacher collaboration.
- Four projects offered the opportunity to enroll in graduate courses to earn credits toward a master's degree or an education credential, and 2 projects offered participants the opportunity to attend conferences.
- Seven projects offered coaching or mentoring to participants and 6 focused on providing leadership training.

Types of Research Designs Used

- Twelve projects successfully employed quasi-experimental designs that included comparison groups, and 4 projects successfully implemented an experimental design.
- Five of the evaluations found positive impacts of MSP on teacher content knowledge, 5 found positive impacts of MSP on student achievement, and one project found positive impacts on teacher classroom practices.[26]
- Seven projects did not find any positive findings. In some cases, this may have been due to small sample sizes which were not large enough to be able to detect statistically significant findings.

Patterns from Projects with Positive Findings

- Of those with *positive findings*, all but one conducted a summer institute, as defined and encouraged by the ED MSP program. Of the projects without positive findings, none conducted a summer institute, although many held summer workshops.
- All projects with *positive findings in student achievement* explicitly stated in their APR text that they aimed to improve both teacher content knowledge and student achievement.
- Eighty percent of projects with *positive findings in teacher content knowledge* explicitly identified this as a goal.

[26] One project found positive findings both for teacher content knowledge and student achievement, and one project found positive findings both in teacher content and teacher classroom practices.

Exhibit 33. Selected MSP Projects

MSP Project	State	Participants	Content Area	Professional Development	Design of Passing Evaluation(s)	Evaluations with Positive Findings
Project Teacher Improvement through Mathematics Instruction (T.I.M.E.)	AZ	66 K-3rd grade teachers	Math	Summer institute plus three weekend workshops during the school year	QED (2)	Teacher content knowledge Classroom practice
Yavapai County Math and Science Partnership – MSP2 Science	AZ	23 K-5th grade teachers	Science	Four-day summer workshop plus school-year weekend workshops	QED	Teacher content knowledge
Conceptual Understanding of Biological Science (CUBS2)	AZ	26 K-8 teachers	Science	Six school-year weekend workshops followed by a five-day summer workshop	QED	None
South Bay Mathematics Collaborative	CA	114 5th-7th grade teachers	Math	30-hour summer workshop plus 30 hours of workshop sessions, 24 hours of classroom coaching	QED	None
Carpinteria and Santa Barbara School – Community Science Initiative	CA	43 4th-6th grade teachers	Science	40-hour summer workshop plus 20-24 hours of follow up sessions and lesson study activities	QED	None
Achievement in Little Lake for Mathematics (ALL for Math)	CA	60 elementary and middle teachers	Math	At least one 10-week content course at IHE, plus district mini-courses	QED	None
Sacramento Algebra Collaborative	CA	14 5th-8th grade teachers	Math	Summer institute followed by 6 hours of school year coaching and 18 hours of lesson study.	QED	Student achievement
Eastern Shore Math Consortium (ESMC) IV	MD	25 4th-8th grade teachers	Math	5-day summer workshop preceded and followed by workshops. Online discussion board and mentoring.	QED	None
Creating High Achievement in Mathematics and Problem Solving (CHAMPS) Year 3	MS	150 5th-8th grade teachers	Math	Summer institute followed by four Saturday mini-conferences, plus mentoring, classroom visits, and an online community/resource center.	RCT	Student achievement
Partnership to Improve Student Achievement through Real World Learning in Engineering, Science, Mathematics, and Technology	NJ	46 elementary teachers	Science	Summer institute plus school-year follow-up including 2 workshops, an online session, monthly classroom visits, and a 3-day institute.	QED	Student achievement
Establishing Excellence in Education for Mathematics and Science (ESTEEMS) II	NJ	43 3rd-5th grade teachers	Math and Science	Summer institute plus 2-3 follow-up days during the school year and mentoring	QED (2)	Student achievement Teacher content knowledge
Allegheny Intermediate Unit MSP of Southwestern PA	PA	136 K–12th grade teachers; 9 admins	Math and Science	Summer & school year academies, lab experiences, and content courses	QED	None
Tennessee Pre-Engineering Math Science Research Partnership	TN	57 7th-12th grade teachers	Engin-eering	Summer institute plus two follow-up Saturday workshops per semester	RCT	Teacher content knowledge
Upper Cumberland Middle Grades Science Research Partnership	TN	40 5th-8th grade science teachers	Science	Summer institute plus two follow-up days and a graduate-level course	RCT	Teacher content knowledge
Rice Regional Science Collaborative	TX	72 3rd-5th grade teachers	Science	Weekly training, student and peer observation, 4 annual campus support visits	QED	None
Understanding the World through the Language of Math: Math Literacy for All	WI	200 elementary teachers	Math	6 school-year days plus a capstone Summer Institute	RCT	Student achievement

Sources: Performance Period 2009 APRs

Project Teacher Improvement through Mathematics Instruction (T.I.M.E.)

State (APR) ID: Arizona (AZ080914)
Partners: Tucson Unified School District, the University of Arizona, and Creative Research Associates
Project Director: Lorrane McPherson and Dr. Rebecca McGraw
Number of Participants: 66 K-3rd grade teachers from 24 public elementary schools and 2 teachers from local private schools

Background:
The T.I.M.E. project received a one-year continuation grant to build on the work begun in the two-week K-3 summer institute held in June 2009. The goals of the project were threefold: to increase the number of teachers who are highly qualified to teach mathematics at the elementary and middle school level, to improve the mathematics achievement of students in target schools, and to provide a professional development program for mathematics teachers in target schools.

Description of Professional Development:
IHE partners facilitated 60 hours of professional development during a summer institute in 2010 using curricula developed by a mathematics professor and aligned with state standards and current school curriculum. Participants engaged in problem solving in four content modules chosen based on data trends from annual state and standardized assessments: number operations (with connections to ratio and proportion), algebraic thinking, fractions, and geometry. Teachers also worked with Cognitively Guided Instruction to design contextual problems, interview young learners using an interview protocol, and read and respond to relevant professional literature. All activities were designed to address four components of effective professional development: learn the content, reinforce the content, consolidate the learning, and implement the learning. After the completion of the summer institute, district K-5 mathematics specialists worked with professional development participants for 18 follow-up day hours and supervised 8 hours of state-approved time outside work. During the follow-up sessions, the content areas focused on in the professional development sessions were reinforced with activities that included collaborative lesson planning, student engagement, problem analysis and creation, ELL support strategies, professional literature study, examination of student work, and understanding of the state math standards.

Description of Evaluations with Rigorous Designs: Evaluations of *classroom practices* and *teacher content knowledge* both passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of these evaluations are each described below.

Classroom Practices
Evaluators used a matched comparison group design to assess whether K-3rd grade teachers participating in T.I.M.E. professional development increased their use of instruction aligned with science and mathematics standards following their professional development sessions. Sixty-six T.I.M.E. teachers were matched to

> The most helpful part was when we decomposed the State Mandated Mathematics Curriculum. It gave me a powerful feeling when I realized that I was already using logic and problem solving. It is very important to use problem solving in all the areas of the mathematics curriculum since this will train their minds to become problem solvers in upper grades and later on in life. It gives them the tools to see different solutions to the same problem making them more flexible.
>
> It was interesting to play the role of student. I definitely became aware of how important it is for me to see myself as a learner of mathematics, not just the teacher. I also became aware of how many different approaches there were to solving the same problem. Each approach made me look at the concept more in-depth. The discussion made the class more powerful for me.
>
> *—T.I.M.E. participants*

57 comparison teachers in the same grade level who did not participate in the professional development and had similar teaching experiences, teaching degrees, and worked in schools with similar demographic data. Each teacher's instructional practices were scored during two classroom observations using the Reformed Teaching Observation Protocol (RTOP)—one prior to T.I.M.E. professional development and one after treatment teachers received the training.

Evaluators found that teachers participating in T.I.M.E. made significantly greater gains on the RTOP than did the comparison teachers—86.2 percent of the T.I.M.E. teachers showed an increase in the Total RTOP mean score from pretest to post-test compared with 59.6 percent of comparison teachers. Moreover, treatment teachers gained more than the comparison teachers on the Lesson Design/Implementation, Propositional Knowledge, Procedural Knowledge, Communicative Interactions and Student/Teacher Relationships sub-scales.

Teacher Content Knowledge

Using the same sample assessed for changes in classroom practices (66 treatment teachers and a matched comparison group of 57 comparison teachers), evaluators examined whether teachers who participated in T.I.M.E. had larger gains on the standardized Learning Mathematics for Teaching (LMT) test than did comparison teachers without the professional development.

Evaluators reported that T.I.M.E teachers made significantly larger gains on the LMT test on than did comparison teachers. Ninety four percent of the T.I.M.E. participants showed an increase in total LMT score from pretest to posttest compared with 56.1 percent of comparison teachers. In addition, more treatment teachers had positive gains on each of the subscales (Numbers, Algebra, and Geometry) than did the comparison teachers. Because the LMT test is a nationally standardized test with strong reliability and validity, evaluators believe that their findings provide convincing evidence of the positive effects of the T.I.M.E. program on their teachers.

Yavapai County Math and Science Partnership – MSP2 Science

State (APR) ID: Arizona (AZ080915)
Partners: Nine school districts, five schools, Northern Arizona University Center for Science Teaching and Learning, Yavapai County Education Service Agency, and an external evaluator
Project Director: Melissa Lawrence
Number of Participants: 23 elementary teachers and 3 middle school teachers

Background:
The Yavapai County Math and Science Partnership (MSP2) is an ongoing project geared toward the development of quality teaching and learning to support student achievement in physical science. Schools that participated had evidence of teachers with limited science content knowledge or who were not "appropriately certified" in science, did not achieve Annual Yearly Progress (AYP), or showed low test scores in science on district or state assessments or norm referenced tests. The goal of the project was to increase the content knowledge of K-5 elementary school teachers in physical science and to expose them to inquiry-based teaching strategies. MSP2 also offered teachers strategies to integrate science with literacy and deepened their understanding of the Arizona science standards.

Description of Professional Development:
The professional development was designed and presented by a Northern Arizona University (NAU) Professor of Science Education and staff of the NAU Center for Science Teaching and Learning, and consisted of seven weekend workshops and a four-day summer workshop. The project addressed specific Arizona Physical Science standards. Participants engaged in hands-on investigations, cooperative learning groups, interpretation of data projects, agreement circles to communicate scientific concepts, use of science notebooks, reflection assignments, and use of exemplary science curriculum material. One teacher-implemented lesson was observed, followed by a one-on-one coaching session, allowing for professional collaboration and reflection. Professional development instructors used modeling inquiry-based instruction, hands-on investigations, inquiry-based science curriculum materials, on-line science modules, videos, homework assignments, assessments, and research-based professional readings.

Description of Evaluations with Rigorous Designs: An evaluation of *teacher content knowledge* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Evaluators used an unmatched comparison group design to determine whether 26 teachers who participated in MSP2 professional development scored higher on the Diagnostic Teacher Assessments in Math and Science (DTAMS) than did 30 teachers in the comparison group. Because of difficulties recruiting a comparison group, comparison group data was derived from another MSP project's comparison group data and evaluators attempted to match on the basis of years of experience, grade level taught, certification, gender, and courses completed in physical science.

> I cannot begin to express the impact this year's training has had on me... I learned how to do inquiry based learning and how to assess my students' understanding quickly and effectively. I learned how to use notebooks [as] a learning tool for my students… I can learn the content as I teach and have been given the resources through the grant to do that. The methods of instruction I have seen modeled will dramatically improve the way I present that content to my students. My enthusiasm will be contagious and I will share those methods with my peers.
>
> *—MSP2 participant*

Researchers reported that more MSP2 participants had statistically significant increases in physical science content knowledge than did the comparison group. Twenty-five of 26 treatment teachers showed increases on this section of DTAMS, versus 11 of 30 comparison teachers.

Conceptual Understanding of Biological Science (CUBS2) Project

State (APR) ID: Arizona (AZ080916)
Partners: 3 school districts, 1 charter school, 2 departments of 1 institution of higher education, 1 educational services agency, and one consulting company/external evaluator
Project Director: Cheryl Mango-Paget
Number of Participants: 24 elementary and 2 middle school teachers

Background: CUBS2 is a professional development program designed to address the need for quality science instruction in elementary classrooms. Professional development efforts focused on increasing participating K-8 teachers' knowledge of key biological sciences content topics (components, organization, energy, and diversity of life, energy flows/matter cycles, and ecosystems and balance) and increasing their capacity to teach science through inquiry-based approaches. Modeling of exemplary instructional strategies, and the opportunity to experience lessons as active learners, allowed teachers to understand direct application of content to their classrooms. The CUBS1 project also met with principals to help them understand the scope of what participating teachers would learn and implement.

Description of Professional Development: Professional development was delivered throughout the 2009-2010 academic school year over six weekends, followed by a five-day summer workshop in June of 2010. These sessions combined instruction integrated to build teacher biological science content knowledge with grade level classroom application. Pedagogical strategies were modeled during content instruction including: inquiry, the nature of science, use of a learning cycle, use of formative assessments, and science notebooks. Between weekend sessions participants were assigned readings from pedagogical resources and required to implement and reflect on the use of these strategies in their classrooms. Formative observations and feedback of participant's science instruction as well as collaborative demonstration lessons gave teachers additional practice in both content and pedagogical implementation of course content. All of these in class and school based activities combined for a total of 105 instructional contact hours. In addition, teachers were provided with and taught how to utilize several professional resources.

Description of Evaluations with Rigorous Designs: An evaluation of *teacher classroom practices* passed the rigorous criteria used to determine if an evaluation was conducted successfully. The design and findings of this evaluation are described below.

CUBS2's classroom practices evaluation using the Reformed Teaching Observation Protocol (RTOP) was conducted successfully. Evaluators used a matched comparison group design to assess whether teachers participating in CUBS2 professional development used instruction aligned with science and mathematics standards. Twenty six (26) CUBS2 treatment teachers were matched to 24 comparison teachers in the same grade level who did not participate in the professional development and with similar years of teaching experience, number of college life science courses, and highest degree attained. Each teacher's instructional practices were scored during two classroom observations – one prior to CUBS2 professional development and one after treatment teachers received the training.

> The MSP programs through the CSTL have completely changed me as a teacher. I no longer give my students meaningless facts out of context, but instead encourage them to address learning with a spirit of curiosity and exploration. This has carried over into the other subject areas I teach as well.
>
> *—CUBS2 participant*

Evaluators reported no significant differences in post observation scores between treatment teachers and comparison teachers. Because this evaluation had a small sample size, it is possible that it did not

have sufficient power to detect significant findings. Differences in passing rates between treated and comparison teachers may be greater than this evaluation was able to detect.

South Bay Mathematics Collaborative (SMBC)

State (APR) ID: California (CA090708)
Partners: 2 school districts, one IHE, and the county office of education
Project Director: Sharon DeAngelo
Number of Participants: 114 elementary and secondary mathematics teachers in grades 5- 7 and all Algebra 1-related courses

Background: SBMC is a comprehensive professional development program in content knowledge and pedagogy for 5th, 6th, 7th and Algebra 1 mathematics teachers of 7,980 students. Partners included a "high-need" LEA with over 99.7% enrolled in the free/reduced lunch program and one borderline school district (25.5% in the free/reduced lunch program, in danger of becoming a Program Improvement district, with four schools in academic decline). Over half of their combined student population and schools were located in a concentrated poverty area. The partnership's primary goals are: (1) enhance teachers' content and pedagogical knowledge; (2) prepare mathematics teachers to provide standards-based instruction; and, ultimately, (3) eliminate the achievement gap in mathematics for African-American, Hispanic, and socio-economically disadvantaged students.

Description of Professional Development: SBMC includes three types of professional development activities: (1) IHE-provided math professional development days; (2) cohort and site-based professional development through department or grade level meetings; (3) individual coaching sessions and demonstrations in participating teachers' classrooms, as well as small group meetings of SBMC participants focused on collaborative planning and lesson development. The professional development was presented by university-coach-teacher leader teams. The structure included content and pedagogy sessions, connecting the standards to college-level mathematics, and connecting pedagogical strategies to the content. Additionally, pacing guides and local assessments were revised by participants during the institute. These activities were chosen to match ongoing reform efforts in the districts, as well as to focus on research-based best practices to improve student achievement. Several techniques were used by facilitators, including lecture, hands-on activities, discussion groups, use of web-based resources, and collaborative planning.

Description of Evaluation with Rigorous Design: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

In order to determine whether students of the SBMC achieved higher scores on the California Standards Test (CST) in mathematics, evaluators used a matched comparison group design. 166 treatment students from 25 treatment classrooms were matched to 166 comparison students from 28 comparison classrooms. The matching process had two steps. First each treatment teacher was matched to a comparison teacher who did not participate in the MSP professional development, who taught in the same grade level and school, district or partnership, and who had the same level of teaching experience and credentials. Each treatment student then was paired with a comparison teacher's student with the same demographic characteristics and prior achievement scores.

Researchers reported that Grade 3-6 SBMC students who were taught by partnership teachers were not significantly more likely to score at grade level on their mathematics CST than were students who had not been taught by partnership teachers. On average, students in the SBMC group scored at grade level about half the time (51% of treatment students). Comparison student outcomes were not significantly different (50% of comparison students at grade level). Because this evaluation had a small sample size, it is possible that it did not have sufficient power to detect significant findings. Differences in passing rates between treated and comparison students may be greater than this evaluation was able to detect.

Carpinteria and Santa Barbara School Community Science Initiative

State (APR) ID: California CA090709
Partners: 2 school districts, departments and institutes at 2 IHEs, 2 foundations, 1 museum, and WestEd
Project Director: Carrie Everstine
Number of Participants: 41 elementary school teachers and 2 middle school teachers

Background: Science Matters envisions a quality elementary school teacher workforce able to align subject matter to the state science standards, effectively use a variety of instructional strategies and resources to raise student achievement, and engage diverse populations of students into pursuing science careers. Professional development activities have included a one week summer workshop; ongoing institutes throughout the year focusing on Life, Earth and Physical Science; and workshops on reading and writing strategies in science, curriculum mapping, student assessment and lesson study. Participating teachers are engaged in an extensive and rigorous lesson study process in which teams of teachers observe and critique lessons and collaborate to improve science instruction.

Description of Professional Development: Content experts from the local university and school sites as well as local institutions (such as the Museum of Natural History) were hired to provide the teachers with the 40 hours of intensive training for the 5-day summer workshop and the additional 20 hours of intensive training spread throughout the remainder of the year. The teachers chose enduring standards at the beginning of the grant from each science content area to focus on over the 3 years of the grant. These standards represent the key standards that are needed to be successful in subsequent grades of science. The focus of year one was on physical science, year two was on life science, and the third year focused on earth science. During the intensive trainings the facilitators taught the content at an elevated academic level via lectures and visual aids, and then the teachers worked with the presenter to create grade-appropriate lessons and activities for use in the classroom. For the 24 hours of follow-up the teachers were trained on Lesson Study, and groups of 3-4 teachers implemented the Lesson Study model in their classrooms, using lessons that had been presented at the content trainings.

Description of Evaluations with Rigorous Designs: Two evaluations of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

In order to determine whether students in Science Matter achieved higher scores on WestEd's Partnership for the Assessment of Standards-Based Science (PASS) multiple-choice test, evaluators used a comparison group design and adjusted for initial differences between groups. Differences between the treatment students and comparison students were controlled for through the calculation of effect sizes and use of multiple regression. In the successful evaluations for 4th grade students, 182 treatment students were compared to 49 comparison students on physical science and life science; for 6th grade students, 114 treatment students were compared to 81 comparison students on all science test scores, physical science, and life science. Within each grade, these treatment and comparison students were shown to be comparable enough for a successful evaluation.

Researchers reported students of those teachers receiving professional development through Science Matters did not perform any better than students of those teachers in the comparison group. Treatment students did have statistically significant gains in scores over the course of the year. For example, 6th grade students in the treatment group averaged 42% on the science tests at the beginning of the school year; at the year-end post-test, they averaged 50%. After adjusting for initial differences, comparison group gains were similar. Because this evaluation had a small sample size, it is possible that it did not have sufficient power to detect significant findings. Differences in PASS scores between treated and comparison students may be greater than these evaluations were able to detect.

Achievement in Little Lake for Mathematics (ALL for Math) - C4 Year Three

State (APR) ID: California (CA090713)
Partners: One IHE, one school district, and an external evaluator
Project Director: Maria Soto
Number of Participants: 24 elementary and 36 middle grade teachers

Background: The project continues to work towards identifying leaders within the district and improving teacher attitudes towards teaching the subject of mathematics. Partners in the grant continue to meet to develop plans to attain all goals set forth in the grant. The next steps include involving administrators in lesson study activities in order to increase their awareness of issues surrounding the teaching and learning of mathematics.

Description of Professional Development: The UCLA Math Content Program for Teachers (T-MATHCOURSE) is designed for teachers who want to increase their competence in mathematics, and it is fully correlated to the California Mathematics Content Standards (CA SBE, 2006). T-MATHCOURSE is aimed at middle school mathematics, but includes topics from elementary and high school mathematics as well. Mathematicians and educators from California helped to develop the T-MATHCOURSE materials, and the faculty advisor (part of the ALL for Math leadership team) plays a substantial role in writing, editing, and instruction. 46 teachers have taken one of the five math content courses that were offered during the grant period. The district has hosted three buy-back days with math content as the focus, including problem solving, fractions, functions, algebra readiness (in alignment with new district curriculum), and English Language Learner math strategies. Additionally, teachers attended after-school mini-course workshops, facilitated by the district math coach, on such topics as equivalencies, operations with fractions, and basic technology skills with a focus on the application "Equation Editor."

Description of Evaluation with Rigorous Design: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

ALL for Math's student achievement evaluation of CST mathematics proficiency in school year 2009-2010 was conducted successfully. In order to determine whether students of the ALL for Math teachers achieved higher scores on the California Standards Test (CST) in mathematics, evaluators used a matched comparison group design. 43 treatment students (from 7 treatment classrooms) were matched to 43 comparison students (from 6 comparison classrooms). The matching process had two steps. First each treatment teacher was matched to a comparison teacher who did not participate in the MSP professional development, who taught in the same grade level and school, district or partnership, and who had the same level of teaching experience and credentials. Each treatment student then was paired with a comparison teacher's student with the same demographic characteristics and prior achievement scores.

Researchers reported that treatment students, who were taught by partnership teachers, were not significantly more likely to score at grade level on their mathematics CST than were students who had not been taught by partnership teachers. Researchers report that treatment students appear to score somewhat higher compared to their peers in the comparison group. Sixty-seven percent of students in the treatment group scored at grade level, while 65% of the comparison group did so.

Sacramento Algebra Collaborative - C4 Year Three

State (APR) ID: California (CA090717)
Partners: Sacramento City Unified School District, California State University: Sacramento, and the Sacramento County Office of Education
Project Director: Susan Haren
Number of Participants: 5 elementary and 10 middle school core content teachers, 2 special education middle school teachers and 3 middle school ELL teachers

Background: The overriding goal of the Sacramento Algebra Collaborative (SAC) project is to increase the number of students who take and are successful in Algebra, by improving the content knowledge and pedagogical skills of their teachers. The intensive phase of the program included a summer institute where teachers focused on proportional reasoning, building fraction sense, solving word problems, developing area formulas, and providing opportunities for teacher collaboration and planning. During the year, teachers continued to receive coaching and participated in Lesson Studies focused on developing, planning, delivering and refining the lesson study instructional plan. With 14 teachers participating and completing the 60 hours of the intensive phase and 17 teachers participating in follow-up activities, approximately 1905 students were impacted by the teachers' participation in the grant.

Description of Professional Development: The content focus of the summer institute was determined after input from the local evaluator and the coaches about areas of need for the teachers in order to improve student performance. The IHE faculty team designed and taught all phases of the intensive instruction, modeling instructional strategies to reach and engage each teacher-learner and to help build connections between mathematical topics. New content foci included proportional reasoning, building fraction sense, solving word problems, and developing area formulas. Additional topics included opportunities for teacher collaboration and planning, and developing collaborative behaviors and norms. For the follow-up work, Lesson Study was selected as a way to support teachers in creating more conceptual lessons using questions to engage students. Lastly, coaches from the IHE visited schools to provide co-planning and coaching according to individual participant needs.

Description of Evaluation with Rigorous Design: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Two SAC student achievement evaluations were conducted successfully comparing student achievement on California Standards Test (CST) Grade 7 Mathematics and Algebra tests, first between 2007 and 2008, then between 2008 and 2009. For each year and CST test, scores for between 118 and 655 treatment students were compared to between 94 and 338 students in matched comparison classrooms. Matching occurred at the level of the teacher: each teacher participating in SAC professional development was matched to a comparison teacher who did not participate, who taught in the same grade level and school, district or partnership, and who had the same level of teaching experience and credentials. Further differences between treatment and comparison groups, including baseline test scores, were controlled for in the analysis of covariance (ANCOVA).

Evaluators found small to moderate positive effects of teachers' SAC participation on students' CST Algebra I skills. They estimate that in 2008, treatment students scored an average of 371.9 on the test versus comparison students' 356.3, controlling for other factors. These findings are repeated in 2009, with treatment students scoring an average of 355.2 versus comparison students' 330.5, controlling for other factors. Estimates for Grade 7 mathematics standards are less promising. Evaluators reported a slight negative influence of teachers' SAC participation on student Grade 7 mathematics scores in both 2008 and 2009.

Eastern Shore Math Consortium (ESMC) IV – Year 2

State (APR) ID: Maryland (MD090701)
Partners: Caroline County Board of Education, Dorchester County Board of Education, Worcester County Public Schools, Salisbury University
Project Director: Bonnie Ennis
Number of Participants: 25 classroom, special education, and ELL 4th-8th grade math teachers

Background: The fourth Eastern Shore Math Consortium (ESMC) professional development program responds to the need caused by high percentages of students in grades 4-8 scoring less than proficient on the math portion of the Maryland State Assessment (MSA) in Local Education Agencies (LEAs) in the four participating ESMC counties. The goal of the project is to increase 4th – 8th grade students in classes taught by Year 1 participating teachers that score proficient or advanced on the MSA in math. The project also aims to increase the number of highly qualified mathematics teachers on the Eastern Shore.

Description of Professional Development: Participants began their program with an orientation in September 2009 that provided an overview and information on expectations for upcoming grant activities throughout the grant year. From December through February 2009, teachers worked through an online grant activity of algebra modules from the Maryland State Department of Education (MSDE). In spring 2010, Salisbury University (SU) professors offered teachers a total of ten additional workshops to provide training for the Praxis II middle school math test and accompanying technology such as graphing calculators, document cameras, and LCD projectors. SU professors also facilitated an online discussion board that provided participants with opportunities to discuss chosen content- and pedagogy-related articles. In summer 2010, the cohort attended a five-day summer program focusing on content knowledge in number relations and computations, instructed by SU mathematics professors. SU professors also met with participants for conferences in pre- and post-classroom observations. Math supervisors conducted observations in the spring of 2010, and again in the fall of 2010, to provide follow-up to their summer program. Lastly, all participants received memberships in both the Maryland Council of Teachers of Mathematics (MCTM) and the National Council of Teachers of Mathematics (NCTM).

Description of Evaluations with Rigorous Designs: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

In order to ascertain the effects of ESMC, changes in passing rates for the treatment group (663 students of 16 teachers who participated in ESMC professional development) were compared to those of two comparison groups whose teachers did not participate in ESMC. One comparison group was comprised of 540 students of 14 teachers; these comparison teachers taught at the same schools, grades, and subjects as the treatment teachers, and, wherever possible, were matched in years of experience. A second comparison group was comprised of 5,544 students in districts in which ESMC was not offered.

Evaluators reported that between 2009 and 2010, the pass rate for treatment students dropped two percentage points to 72 percent. Over the same period, pass rates for comparison students in the same schools declined eight percentage points to 66 percent, and pass rates for comparison students in other districts dropped two percentage points, to 80 percent. Evaluators report that there is little evidence to suggest that teachers' participation in ESMC Cohort VII had a significant positive or negative impact on his or her students' performance on the math MSA.

Creating High Achievement in Mathematics and Problem Solving (CHAMPS) Year 3

State (APR) ID: Mississippi (MS070610)
Partners: 14 school districts, one school, three counties, Old Fashion Products, Inc., MUGGINS! Math
Project Director: Kate Brown
Number of Participants: 89 elementary school teachers, 43 middle school teachers, and 18 high school teachers, including core content, gifted and talented, and special education teachers

Background: The CHAMPS Project serves teachers in seventeen Mississippi districts demonstrating high levels of poverty and low student achievement. CHAMPS proposes to raise the achievement of economically disadvantaged students in mathematics by providing an intensive professional development program to middle grade teachers. In addition to increasing teacher content knowledge, CHAMPS targets critical teaching issues relevant to 5th-8th grade mathematics teachers including math pedagogy, standards-based teaching, leadership training, training in the use of the Understanding by Design framework, and the use of manipulatives and technology in the math classroom.

Description of Professional Development: The summer institute was an intensive, two-week experience, which focused on the content covered by the 5th-8th grade Mississippi Curriculum Framework for mathematics, the NCTM Curriculum Focal Points for Pre-K through Grade 8 Mathematics, and the alignment of the curriculum with the Understanding by Design Framework. The content was presented by master teachers in mathematics. CHAMPS also offered four follow-up Super Saturday mini-conferences, which provided a variety of professional development activities for teachers. To complement the summer institute and Super Saturdays, CHAMPS established a mentoring program that paired participants with an IHE faculty member; classroom visits throughout the school year; the opportunity to attend state, regional, and national conferences in mathematics; an online community using WebCT; an interactive project website; and a Mathematics Resource Center.

Description of Evaluations with Rigorous Designs: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

A group of 50 teachers was randomly assigned to either receive CHAMPS mentoring (25 teachers) or to the control group (25 teachers). After some teachers left, the treatment group consisted of 22 teachers and the control group, 18. This attrition jeopardized comparability between the two groups, but evaluators accounted for any such differences in their analysis. Gains in MCT2 scores were compared between 574 treatment students whose teachers had CHAMPS mentors and 314 control students whose teachers did not participate in the program.

> This program truly encourages the teachers to think about ways to engage their students with exciting activities and hands-on experiences.
>
> It is always enlightening to remember what it's like to be in the student role, rather than just the teacher's. I can relate to my student's struggles more. I find myself allowing them more wait time, encouraging them to help each other and providing opportunities that are more engaging than before.
>
> *—CHAMPS participants*

For 2008-2009, evaluators reported that students whose teachers were mentored showed a trend of increasing mean MCT2 scores (14.76%), as compared with students whose teachers were in the control group (13.71%). These results were stronger in the following year. In 2009-2010, students whose teachers were mentored showed significantly higher scores on MCT2 (51.18), compared to students whose teachers were in the control group (49.23).

Partnership to Improve Student Achievement through Real World Learning in Engineering, Science, Mathematics, and Technology (PISA)

State (APR) ID: New Jersey (NJ070715)
Partners: Four school districts, six schools, three IHEs, and the Liberty Science Center
Project Director: Beth McGrath
Number of Participants: 46 elementary school teachers

Background: The Partnership to Improve Student Achievement (PISA) program works to improve student achievement in STEM through 1) bolstering teachers' content knowledge in STEM; 2) promoting the use of model-based inquiry in science learning; 3) integrating the engineering design process to solve real-world problems; and 4) providing continuous learning opportunities through professional development, classroom mentoring, and support. The goal of the PISA program is to: (a) demonstrate and institutionalize a methodology, supporting curriculum materials, and other instructional resources and strategies to increase student interest, engagement, and achievement in STEM and further, to (b) promote a culture of inventiveness that calls upon students to demonstrate 21st century workforce skills and to apply science and mathematics toward the solution of relevant, real-world problems. Key outcomes include: increasing the number of highly qualified teachers in elementary science classrooms; use of inquiry-based science and of research-based, interdisciplinary, hands-on curricula and instructional strategies; and, increased student learning of STEM topics and processes. Each year of PISA has focused on a different science discipline. This final year of the program has been devoted to topics in physical science and related mathematics content including measurement, algebra, and data analysis.

Description of Professional Development: Teachers received a total of 124 hours of professional development through a summer institute with direct instruction and independent work, two workshops and one online session during the school year, monthly classroom visits to each teacher, a culminating three day institute near the end of the school year, and online support. Professional development was provided by higher education faculty in physics and education, STEM professional development specialists, and science museum staff. A variety of strategies were used to engage partner teachers and deepen their understanding of college level physics and related math content including modeling scientific inquiry through hands-on investigations, presenting problem-based learning (PBL) opportunities, providing engineering design experiences directly pertaining to the physics concepts, requiring independent homework assignments, and facilitating multi-level discourses. Teachers also explored computer-based technology applications, laboratory experiments and demonstrations, and grade-specific lessons and related pedagogy. As part of the program, teachers

> The Physical Science part of the PISA program was very beneficial. I did not like teaching this part of science because I didn't have a thorough understanding of the topics myself, but also because I didn't understand the activities and labs that I was finding to use with the students. After this past year, I feel much more confident teaching the material.
>
> The engineering design process levels the playing field for remedial and gifted learners. Remedial learners have an instinctual focus to change things and make them better for themselves. They tend to teach themselves in a way that they can better understand so they are always "redesigning" information to make it easier for them to internalize. Gifted learners are looking for alternate ways of processing information. They tend to look at lessons in a "been there, done that" sort of way. When they can be in control of where they take what they have learned and apply it in a real world situation, they run with it. The Engineering design process is the best way to help students apply the content they have learned.
>
> *—PISA participants*

designed a fully-developed physical science PBL activity to be implemented in their classroom. In-class support was provided to help them plan and introduce the physics concepts covered in the PBL activity.

Description of Evaluations with Rigorous Designs: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

PISA drew on pre-existing tests to customize an assessment for the subjects covered in each year's professional development; the student test was comprised of 12 physical sciences questions from MOSART, 3 math questions from TIMMS, and 5 engineering questions from the Engineering is Elementary curriculum published by the Museum of Science, Boston. A total of 1,179 students (638 treatment and 541 comparison) took the test at the beginning and end of the school year. Evaluators adjusted for pre-test differences between the groups in the outcomes analysis.

Evaluators reported that the treatment students improved significantly more than did comparison students in their content knowledge. Treatment students had a significant gain in their scores of 46% (from 6.68 to 9.77). The comparison group also had a significant increase in their scores, but the increase was only 17% (7.16 to 8.39). Regression results suggest that 1) the more PISA activities a teacher performed, the higher the students' post-test scores, and 2) when PISA activities were conducted by teachers with higher post-test scores, students' post-test scores were higher.

Establishing Excellence in Education for Mathematics and Science (ESTEEMS) II

State (APR) ID: New Jersey (NJ070720)
Partners: Rutgers University, Middlesex County College, ten school districts and five non-public schools
Project Director: Lynda Ginsburg
Number of Participants: 42 3rd-5th grade teachers and 1 high school teacher

Background: An MSP/ESTEEMS needs assessment in 2006 identified a need for standards-based, content-related professional development for grade 3-5 teachers of mathematics, science and special education in ESTEEMS districts and non-public schools. The objectives of ESTEEMS II are: (1) 85 percent of participating teachers will show a 20 percent gain in mathematics content knowledge, a 30 percent gain in science content knowledge relative to control group results, and a 30 percent greater ability to integrate related technology into their classrooms; (2) students of participating teachers will show a 10 percent gain in related mathematics and science content knowledge relative to control group results; (3) all teachers completing 2 or more years of ESTEEMS will be rated as highly qualified; and (4) novice teachers who have completed two or more years of ESTEEMS will have left the teaching profession at a rate 20 percent less than novice teachers in the control group.

Description of Professional Development: To achieve these objectives, ESTEEMS staff contacted prospective participants to discuss their needs, and enrolled them in the Sakai online learning community. Then, teachers attended a 13-day mathematics and science Content Academy where IHE faculty presented a series of hands-on activities, whole group discussions, and modeling activities chosen based on the needs of district partners and the recommendations of the planning team (including STEM faculty) to enhance the current earth science and mathematics curricula in each district. Facilitators designed activities where participants worked in pairs and table teams to solve real-world problems. Participants also strengthened their knowledge of new technology tools, Web 2.0, by using wikis and Google tools, and developed their individual science notebooks. After the summer activities, ESTEEMS coaches/mentors worked with participants in their classrooms for four to six days to identify remaining needs, provided in classroom coaching on content and pedagogical content knowledge, observed implementation of Project Based Learning Scenarios (PBLS)/capstone projects and facilitated collegial reflection on practice. Coaches/mentors also employed strategies aimed at encouraging retention of novice teachers. Participating teachers developed and presented their capstone projects to their administrators, mentors, and fellow teachers.

Description of Evaluations with Rigorous Designs: Evaluations of *teacher content knowledge* and *student achievement* both passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of these evaluations are each described below.

Teacher Content Knowledge
Science scores on the Misconceptions-Oriented Standards-Based Assessment Resources for Teachers (MOSART) from 41 treatment teachers were compared to those from 14 comparison teachers, with teachers matched on educational degree(s) obtained, academic major(s), certification(s), number of years teaching, and subject area, grade, and ability level taught. Treatment and comparison teachers' pre-test science knowledge was sufficiently similar for the groups to be considered comparable.

Evaluators reported that the treatment teachers' average gain was significantly higher than that of comparison teachers. ESTEEMS teachers gained an average of 2.88 points (from 17.54 to 14.66) on a 40 point test. In contrast, comparison teachers improved .22 (from 15.14 to 15.36).

Student Achievement

Students were 686 treatment students of ESTEEMS teachers and 423 comparison students of teachers who did not participate in ESTEEMS. These teachers were matched as described above, on educational degree(s) obtained, academic major(s), certification(s), number of years teaching, and subject area, grade, and ability level taught. Students in treatment and comparison teachers' classrooms were sufficiently similar on pre-test scores that no adjustment was necessary in the analysis.

Evaluators reported that students of ESTEEMS teachers scored significantly higher on the posttest than did students of comparison teachers on a mathematics and earth sciences assessment based on items from the National Assessment of Educational Progress (NAEP) data bank. On the 30-point test, treatment students scored an average of 18.50 while comparison students scored 17.67. Additionally, ESTEEMS students had a significantly higher score on the mathematics portion of the test (9.84 vs. 9.31 for the comparison group). Evaluators report that overall, the ESTEEMS students improved an average of about three points (3 additional correct answers) compared to a two-point gain for the comparison students.

Allegheny Intermediate Unit MSP of Southwestern PA

State (APR) ID: Pennsylvania (PA070715)
Partners: Four IHEs, three intermediate units, and ten school districts.
Project Director: Nancy Bunt
Number of Participants: 136 math and science teachers from elementary, middle, and high school, plus nine school and district administrators, in 2010

Background:
The MSP region includes Pittsburgh's urban fringe, several smaller urban areas, suburbs, and rural areas. There was wide variation in student demographics and achievement levels. The Math & Science Collaborative (MSC) strives to have all its students engaged in a coherent sequence of active learning experiences, appropriate to their developmental level, that are designated to continually increase their competence, resulting in mathematical and scientific literacy. Specifically, the MSP goals included: 1) increasing K–12 students' knowledge of mathematics and science, 2)) increasing the quality of the K-16 educator workforce, and 3) building intentional feedback loops within K-16. To accomplish them, the MSP built leadership cadres within each district and IHE partner, who led their colleagues with training tools and supported networking to changing the teaching and learning of mathematics and science for all students. Additionally, advice was solicited yearly from a group of national experts in the fields of mathematics, science, and related education, who reviewed documents and discussed ways to improve learning opportunities.

Description of Professional Development:
The MSP Partnership worked to provide research-based professional learning experiences for participating educators. In 2009-2010, those professional learning experiences included quarterly Leadership Action Academies, which engaged leadership teams in analyzing data, exploring research-based resources, and building comprehensive action plans for school improvement. LAA teams recruited teachers to deepen content knowledge and pedagogical understanding through Content Short Courses (3-5 days) and in Teacher Leadership Academies (4-15 days). TLAs prepared educators to share information with their colleagues in On-Site Academies (12-24 hours). The LAA team also recruited principals for Eyes on Science seminars (3 days) to build capacity to recognize and support effective science instruction. The Learning Laboratory (3 days) used a "fishbowl" approach for educators to analyze student science and math thinking through first observing real lessons with real students, and then de-briefing to interpret evidence of student learning during the lesson. The Math Coach Network (5 days) deepened content and pedagogical knowledge.

Description of Evaluations with Rigorous Designs: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

The evaluation team conducted a statewide analysis comparing districts participating in MSC (10) with a set of matched comparison districts (566-580) that did not participate in MSC. The comparison group was matched using propensity scores. These propensity scores were estimated using student and district characteristics such as the proportion of economically disadvantaged students, proportion of minority student, proportion of IEP students, overall attendance rate, graduation rate, proportion of emergency certified teachers, and 2002-2003 PSSA performance. Fifth grade students in these districts were deemed to be sufficiently comparable across treatment and comparison groups.

Evaluators reported that in 2008-2009, fifth grade students in treatment districts scored an average of 1360 on the on the Pennsylvania System of School Assessment (PSSA) in math. In contrast, fifth grade students in the comparison districts (weighted by propensity score) scored an average of 1445.

Tennessee Pre-Engineering Math Science Research Partnership

State (APR) ID: Tennessee (TN080108)
Partners: 17 school districts, 1 public high school, 2 universities, 1 community college
Project Director: Kenneth Hunter
Number of Participants: 57 7th-12th grade science, math, and career-technical teachers

Background: The Oakley STEM Center and College of Engineering at Tennessee Tech University, in partnership with Northeast State Technical Community College, the University of Tennessee at Martin, and LEAs across Tennessee, are implementing a three-year professional development research partnership in pre-engineering. Goals include increased teacher content knowledge of math, science and engineering; teacher use of technology in their classrooms; and increased student knowledge in science, math, and engineering.

Description of Professional Development: The professional development model consists of a 7-day, 60-hour summer institute at Tennessee Tech and two 6-hour Saturday workshops per semester held at three locations statewide. The summer institute was built around the first principles of engineering and the 2009 Tennessee math and science curriculum standards. The majority of the content consisted of engineering topics, including aerospace, civil, computer, electrical, mechanical, and renewable energy engineering, presented by engineering faculty with inquiry-based, hands-on instruction. Specific activities were chosen to provide a basis for teacher-developed, standards-based lesson plans. Participants also took field trips to relevant sites and completed a team design project in which they designed, built, and tested a submersible, remotely-operable-vehicle and a system for containing a simulated oil well blowout. In addition, pedagogical instruction on instruction technology, the Legacy Cycle Model, and a standards review, was presented by education faculty and master teachers. All participants completed lesson plans based on summer institute content and the Legacy Cycle Model. After the institute, follow-up workshops were repeated on each of the partner campuses and included technical sessions that built on summer institute topics. The final workshop each fall engaged teachers in the collection of student achievement data from the Tennessee Department of Education database (TVAAS), which is used to measure student gains.

Description of Evaluations with Rigorous Designs: An evaluation of *teacher content knowledge* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Sixty teachers were randomly assigned to professional development and another 60 randomly assigned to the control group. In 2010, 58 treatment teachers and 36 comparison teachers completed both a pre-test and post-test of math content knowledge on the Junior Engineering Technical Society (JETS) Assess math test.

Evaluators reported significantly greater gains in content knowledge for teachers in the treatment group than in the control group. Fifty two percent of teachers (30 of 58) participating in the summer institute achieved significant gains on the math portion of JETS Assess, with average score increases of 21.3%. In contrast, control teachers showed no significant gains.

Upper Cumberland Middle Grades Science Research Partnership

State (APR) ID: Tennessee (TN080109)
Partners: 14 school districts and Tennessee Technological University
Project Director: Dr. Susan Gore
Number of Participants: 40 5th-8th grade science teachers

Background:
The partnership began with 50 Intervention teachers and 50 Control teachers from 13 partner school systems with the goal of increasing teacher content knowledge, student interest in science, and student achievement in science. Intervention teachers attend a two-week summer institute and four professional development days throughout the year. Both groups take pre/post content knowledge tests and administer a pre/post interest survey to their students. When teacher numbers fluctuate, Intervention teachers are replaced with randomly selected teachers from the Control Group. Recruitment to replace teachers in the Control Group is the responsibility of the district liaison. Partner liaison meetings are held twice yearly, but communication via email is ongoing.

Description of Professional Development:
This is the third summer institute. Summer Institute I focused on Life Science; Summer Institute II focused on Physical Science; Summer Institute III focused on Earth/Space Science. The institute was divided into sessions designed to emphasize the SPIs from the current Science Curriculum Framework, and included hands-on inquiry based learning. Instruction is driven by the current state standards in grades 5 through 8. Sessions were presented by content area specialists from the College of Arts and Science and the College of Education. Two follow-up days were provided—one to enrich the content learned during the summer institute, and the other to gather and analyze student test data. In addition, a one credit hour, no cost, graduate level course is offered to all Intervention teachers each fall semester.

Description of Evaluations with Rigorous Designs: An evaluation of *teacher content knowledge* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Each partner district submitted a list of teachers eligible for the project. Fifty teachers from each partner district list were randomly assigned to the treatment group and 54 to the control group. When participants were lost from the treatment group because of attrition, the random selection process was again used to select a replacement from the control group to fill the vacant slot. Content knowledge scores on the Diagnostic Teacher Assessments in Math and Science (DTAMS) were tracked across time to determine any differences in gains between the two groups of teachers.

Evaluators reported that the average gain in content knowledge for the treatment group was significantly higher than that of the control group. Treatment teachers achieved an average of 6.4 additional points at posttest (from 19.6 to 26.0). In contrast, control teachers achieved an average of 1.9 additional points at posttest (from 20.0 to 21.9). Treatment teachers improved their DTAMS scores between pre-test and posttest and improved more than did the control group.

Rice Regional Science Collaborative for Excellence in Science Teaching

State (APR) ID: Texas (TX090510)
Partners: 22 independent school districts and Rice University
Project Director: Ronald Sass
Number of Participants: 72 3rd-5th grade science teachers

Background: The mission of the Collaborative is to create a science and technology learning community for teachers by providing long-term, sustained teacher professional development in science content, pedagogy, systemic school reform, and technology. The greater Houston area includes nearly one quarter of the Texas student population, 65 percent of which come from underrepresented minority groups; 54 percent are economically disadvantaged and 18 percent are ELL. Of teachers that participated in REMSL 2009-10 training, only 28 percent have a major in science and 41 percent were unsure if they were "highly-qualified" under NCLB. Fifty-four percent indicated that they teach in high-poverty campuses and 72 percent indicated that their school qualifies as a Title I school. The ultimate aim is to assist science teachers in ensuring that all students have authentic science learning experiences and that technology is fully integrated into instruction. Our program is set up to improve teachers' general science content as it relates to the Texas Essential Knowledge and Skills (TEKS) concepts, delineated by the following broad topics: Nature of Science, Physical Science, Earth/Space Science and Life Science. It is set up to improve teacher instructional skills in guided inquiry learning, constructivist pedagogy, and best practices in elementary science education as identified by research; improve teachers' leadership skills and, ultimately, improve student achievement in science.

Description of Professional Development: The Rice Elementary Model Science Lab (REMSL) is a year-long program using inquiry-based, constructivist teaching practices. The multi-pronged training model was designed to provide four cohorts of approximately 20 participants with a comprehensive set of instructional resources through weekly training lab sessions, ongoing campus support provided by program staff, a set of state aligned curriculum resources, and material resource kits. During content-based morning sessions, participants conducted small-group scientific investigations. These science activities were closely aligned with TEKS to be implemented in elementary classrooms. The afternoon sessions focused on the use of effective teaching practices and offered a variety of pedagogical strategies for successful science learning. The sessions were enriched by presentations from Rice science faculty, teacher field experiences and additional activities led by the instructional team, such as Student Observation Lab and peer mentoring program. Every partnering campus benefited from science curriculum resources based on the 5-E model for lesson planning and included a set of comprehensive hands-on learning experiences. In addition, teacher participants were visited four times per academic year by the Rice instructional team, who offered important feedback on their teaching practices and their perceived student learning.

Description of Evaluations with Rigorous Designs: An evaluation of *teacher classroom practices* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Classroom practices were assessed using the Reformed Teacher Observation Protocol (RTOP) for 60 treatment teachers and 36 comparison teachers who had applied for the program but been deferred for a year. Treatment teachers increased their RTOP rating scores from 40 to 48. This gain was statistically significant. Rating scores for comparison teachers was similar (41 to 49). Evaluators reported that the results – an increase in rating scores that was the same for treatment and comparison teachers – is similar to findings from previous years of REMSL trainings.

Understanding the World through the Language of Mathematics: Math Literacy for All

State (APR) ID: Wisconsin (WI070911)
Partners: 9 school districts, 4 IHEs, and the Dynamic Math Institute
Project Director: Cora Rund
Number of Participants: 200 elementary school teachers

Background: The project grounds its work in the belief that we are responsible for preparing all students to be mathematically proficient for their next level of education, and ultimately, to be productive and informed members of our democratic society and the world. The goals for the project are to increase student mathematical proficiency and achievement, and to increase teacher content knowledge of mathematics, pedagogical skills to meet the needs of all learners, and the knowledge of how students learn mathematics. The goals of the project align with the Wisconsin Model Academic Standards, the Wisconsin Teacher Standards, PI 34, and the goals of NCLB to ensure that all students have equitable access to instruction grounded in research and best practice.

Description of Professional Development: The professional development was structured with a total of six required training days during the school year (48 hours) for participants. These included three days of workshops designed to deepen teacher math content knowledge and three day days dedicated to lesson study and how children learn mathematics. An 80-hour summer institute served as a capstone experience for teachers who applied for admission. Math leadership teams developed in each district provided on-going support for teachers during and after training. Project activities were selected based upon student achievement gaps identified in the needs assessment and state/national math standards and assessments. The activities involve teachers using problem-solving strategies to solve real world problems, applying the concepts in mathematics, demonstrating pedagogical practices, and applying new skills in their classroom. The model supported the increased use of constructivist teaching that engages students in developing understanding through inquiry and the linkage of the five strands, understanding, computing, applying, reasoning, and engaging in rich mathematical thinking – that leads to student proficiency.

Description of Evaluations with Rigorous Designs: An evaluation of *student achievement* passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

A stratified random sample was taken such that 50 percent of teachers from each participating district equally spread across grade levels (PK through 5) were chosen to receive Wisconsin Knowledge and Concept Examination (WKCE) professional development. Math test scores were compared between 227 students in randomly-assigned 2nd grade treatment teachers' classrooms and 245 students in randomly-assigned 2nd grade comparison teachers' classrooms.

> I never realized the foundation for algebra that teaching unit seven in Investigations was laying. When introduced to the growing patterns through this activity the light bulb went on for me just as it does for my students when they get the concept being taught...I am so excited to teach this unit now that I understand the concept. I have not been teaching the unit properly and reflect every year when my students do poorly on the assessment. My attitude about teaching this unit has changed and I am excited that my students will now have the opportunity to be successful in the assessment.
>
> *—Math Literacy for All participant*

Evaluators reported that 2nd grade students taught by teachers in the treatment group scored better, on average, than did students taught by teachers in the control group. This difference was reported to be statistically significant. Whereas students in the treatment group scored an average of 34.43, students in the control group scored an average of 32.59.

Chapter 7: Summary and Conclusions

The MSP program was created in 2001 to fund collaborative partnerships between high-need school districts and mathematics, science, and engineering departments at institutions of higher education (IHEs) for the purpose of providing intensive content-rich professional development to teachers and other school staff and thus improving classroom instruction and ultimately student achievement in mathematics and science. Since the program's inception, it has grown to encompass more projects and serve more participants, who, in turn, have served more students. In Performance Period 2009 (PP09), 590 individual MSP projects were in operation throughout the country. These projects provided professional development to nearly 49,000 educators who taught over 2.5 million students, and in some cases, these educators also trained their fellow teachers, thus influencing an even larger number of teachers and students.

In accordance with the legislation, MSP projects established partnerships between school districts and IHEs as well as with a wide variety of other organizations. More than 3,600 faculty members from mathematics, science, engineering, and other departments at IHEs were involved with the MSP projects.

Over half of MSP projects (51 percent) in PP09 conducted summer institutes, a model of professional development designed to provide a period of intensive study of STEM content over a relatively short period of time. Nearly all of the projects that offered summer institutes also conducted follow-up activities, with the aim of enhancing or extending the knowledge gained by participants over the summer. Projects that provided summer institutes with follow-up activities provided participants with a median of 96 hours of professional development. Three percent of projects conducted summer institutes with no follow-up. These projects provided participants with a median of 80 hours of professional development. The remaining 49 percent of MSP projects in PP09 primarily delivered professional development during the school year, with shorter summer sessions often included. These projects also provided participants with a median of 80 hours of professional development.

All projects are required to administer pre- and post-tests during the year(s) in which their teachers were receiving intensive professional development. The most frequently reported assessments of teacher content knowledge in mathematics were standardized tests (63 percent), followed by locally developed tests (34 percent). The use of assessments to measure teacher content knowledge in science was more balanced between standardized and locally developed tests, with 49 percent of assessments used locally developed and 45 percent standardized. The main advantage of standardized tests is that they have already been tested for validity and reliability, and thus their results can be compared in a normative context. However, standardized tests are not available in all disciplines and are often not well aligned with the context taught. Thus, many projects developed their own assessments to measure growth in teacher content knowledge of the material taught, although they may not have had strong psychometric properties.

Nearly two-thirds of participants (62 percent) who were assessed in mathematics showed significant gains in their content knowledge, and nearly three-fourths of teachers (71 percent) who were assessed in science showed significant gains in their content knowledge.

Substantial increases were seen in PP09 in the proportion of students taught by MSP teachers who scored at the proficient level or above in state assessments of mathematics or science. In mathematics, the proportion of students scoring at the proficient level or above (64 percent) increased by 6 percentage points from PP08, a 19 percentage point increase since 2007. In science, the proportion of

students scoring the proficient level or above (63 percent) increased by 5 percentage points from PP08, a 14 percentage point increase since 2007.

As they work to determine the impact of their programs, many projects are attempting to implement rigorous evaluation designs. Three percent of projects reported using experimental designs, and 48 percent of projects reported using quasi-experimental designs with comparison groups. However, upon review of the designs of final-year projects, it was found that many of the projects that reported using quasi-experimental designs in fact used one-group designs comparing outcomes for MSP participants between pre- and post-test.

The Criteria for Classifying Designs of MSP Evaluations were initially developed as part of the Data Quality Initiative (DQI) through the Institute for Education Sciences (IES) at the U.S. Department of Education to identify projects that successfully implemented rigorous evaluation designs. These criteria were modified this year to make them more closely aligned to the review standards used by the What Works Clearinghouse (see Appendix A). The criteria were applied to the final evaluation reports of the 114 projects that completed an experimental or comparison group design and submitted complete data. Sixteen of these projects met the rigorous criteria, more than five times as many as met the criteria in PP08. These sixteen projects varied from one another across the types of program offerings, the content area and grade levels targeted, and the number of professional development hours offered.

Ultimately, the success of the MSP program will be determined by the success of its projects in providing effective professional development to teachers across the nation. The MSP program will continue to study the effectiveness of these efforts in order to develop our understanding of what constitutes high quality, effective professional development.

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Appendix A: Review of Projects with Rigorous Designs

This appendix presents the results of a review of final-year MSP projects that reported using an experimental or quasi-experimental comparison-group design to assess their MSP programs. The goal of the review was to determine the extent to which projects successfully conducted rigorous evaluations to yield findings that could be considered reliable and valid. To this end, we conducted detailed reviews of projects' evaluations to assess the extent to which they met the criteria established for MSP projects for rigorous evaluations of interventions. We describe how the review was conducted, the criteria used to assess the rigor of projects' evaluations, the results of the review, and recommendations that may help improve future MSP project evaluations.

Methodology Used for Review

The primary source of information used in the review was the final evaluation report for each project, supplemented by information provided in annual performance reports (APRs) of PP09. If projects were missing key pieces of information for determining whether or not the project met the rubric criteria, reviewers requested the specific missing information from project staff. If the staff did not return information that allowed reviewers to complete the review, the project was classified as having not met the rubric criteria.

The review process proceeded in two stages by:

1. Defining the set of projects for review, by first identifying those that were in their final year of funding and second by selecting projects whose evaluations met specific criteria for inclusion, discussed in more detail in the next section; and

2. Assessing and scoring project evaluations against a rubric to assess data quality and rigor of implementation of the evaluation.

Each of these stages is described in more detail below.

Defining the Set of Project Evaluations

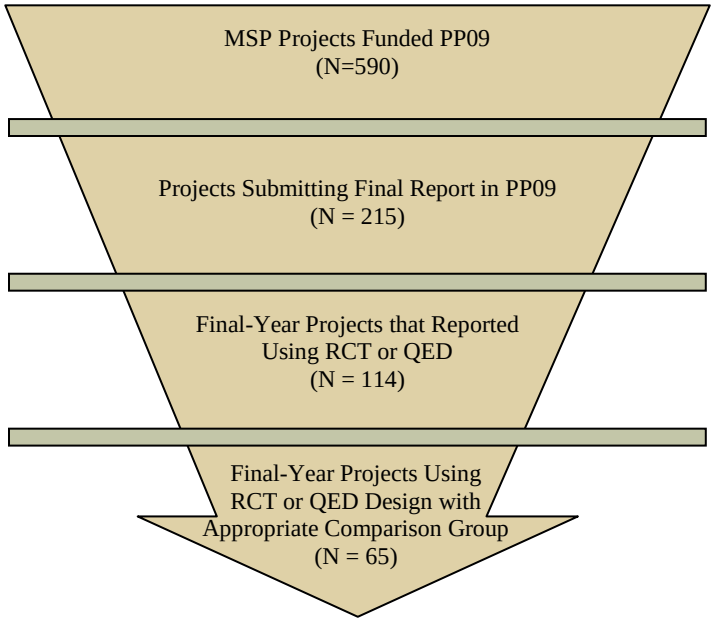
The first step in the review was to identify the projects that were in their final year of funding (Exhibit 34). Out of the 590 projects funded in PP09, only 215 projects that reported that PP09 was their final year were reviewed.

Because the purpose of the review was to learn about projects' impact evaluations, we limited our assessment to those using experimental or quasi-experimental designs, both of which are considered appropriate for testing the impact of an intervention27. Experimental designs, also known as randomized control trials (RCTs), include designs where units of analysis (i.e., teachers, classrooms, or schools) are randomly assigned to a treatment or control group. Quasi-experimental designs (QEDs), on the other hand, are those where units of analysis are assigned to a treatment or control group by some method other than random assignment. Focusing only on projects using these two designs narrowed the set of projects for review from 215 to 114.

[27] For more information on selecting a design that will provide rigorous evidence of effectiveness, see U.S. Department of Education (2003).

We further narrowed the pool of 114 experimental and quasi-experimental projects to 65 by focusing only on those who had completed their evaluations and used a comparison group and provided sufficient data from both groups to review their evaluations. In this step, we excluded some projects because they did not provide sufficient detail about their evaluations,[28] and others because their designs did not include an appropriate comparison group despite being presented as an experimental or quasi-experimental evaluation. For example, some projects evaluated pre- and post-test scores for only a treatment group, or compared treatment group scores to established benchmarks, which contain scores from treated students. The remainder of our discussion focuses on what we learned from reviewing these 65 projects.

Exhibit 34: Sample of MSP Projects Reviewed for Rigor of Evaluations



Sources: Final evaluation reports, annual performance reports, and related documents submitted by MSP projects.

Most of the MSP reports contained separate evaluations of various domains within the same report. For example, a report might examine the effect of MSP on teacher content knowledge *and* student achievement. As these domain assessments were generally self-contained evaluations, they were examined individually in our review.

Reviewed domains were those with strong theoretical links to MSP's goals, including teacher content knowledge, teacher pedagogical content knowledge, teacher classroom practices, and student achievement. If a project conducted research on more than one of these four domains, it was considered to have conducted multiple "evaluations." Reviewers assessed each of these evaluations within a project independently so that only those design elements relevant to the specific evaluation being assessed were considered. Across the final set of 65 projects, reviewers identified 121

[28] Projects that were missing individual data elements were contacted for additional information, but projects that were not able to provide data for the comparison group, or that provided insufficient information to determine the overall design, could not be included in our review.

evaluations.[29] The majority looked at student achievement (52 percent), followed by teacher content knowledge (31 percent), classroom practices (31 percent), and pedagogical content knowledge (4 percent). Our assessment of the rigor of these 121 domain evaluations follows (hereafter referred to as the evaluations).

Assessing MSP Evaluations for Rigor

Project information for each of the 121 evaluations was reviewed to determine the extent to which projects followed the recommendations for evaluation design and implementation specified in the *Criteria for Classifying Designs of MSP Evaluations* (hereafter referred to as the rubric). This rubric was initially developed by Westat as part of the Data Quality Initiative (DQI) at the Institute for Education Sciences (IES) within the U.S. Department of Education and outlines the key elements necessary for implementing a rigorous impact design. These criteria were modified for PP09 to make them more closely aligned to the review standards used by the What Works Clearinghouse (see Appendix B).[30] The criteria specified in the rubric used for assessing the PP09 MSP evaluations were:

1. Data reduction rates
2. Baseline equivalence
3. Use of valid and reliable (or sufficiently tested) measurement instruments;
4. Use of consistent methods, procedures, and time frames to collect key outcome data from the treatment and comparison groups; and
5. Reports of relevant statistics and their statistical significance.

To pass the rubric, evaluations had to satisfy the requirements of each criterion. Of the 121 evaluations reviewed, 20 evaluations within 16 projects successfully met all of the rubric's criteria. Four of the passing evaluations were experimental studies and 16 were quasi-experimental. Twelve of the 20 passing evaluations examined interventions' impacts on student achievement; five examined impacts on teacher content knowledge; and three examined impacts on classroom practices. In the review that follows, we discuss each evaluation's performance on the rubric's five criteria and present recommendations for future project evaluations.

Assessing Comparability of Treatment and Comparison Groups

The first two criteria are used to assess the comparability of treatment and comparison groups. A key component of a rigorous impact design is a comparable treatment and control group. The more comparable these groups are, the more likely it is that any observed differences between the groups are attributable to the interventions studied rather than potential alternative explanations, confounding factors, or biases. The comparability of group is examined in different ways for experimental and quasi-experimental studies.

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[29] Evaluations containing with multiple components in the same domain (i.e., evaluations of teacher content knowledge in algebra and geometry) were still counted as one evaluation.

[30] Sample size was removed as a criterion, and the screening requirements for baseline equivalence and data reduction rates were updated to reflect the unique characteristics of experimental and quasi-experimental designs.

For ***experimental studies***, randomization helps to ensure that the only systematic difference between the treatment and control group is the randomly assigned receipt of the intervention. If randomization is successful, treatment and control groups should be equivalent at baseline. However, there is potential for attrition to change the composition of the two groups used for the analytic sample. In order for groups in the analysis to maintain baseline equivalence (i.e. "baseline equivalence of the analytic sample"), it is important to ensure that there was minimal attrition so that the groups continue to have similar compositions. If attrition between time periods is high, then baseline equivalence of groups among the final analytic sample is required to make the evaluation more rigorous. Thus, to ensure treatment and control group comparability, we first check attrition using *data reduction rates*, and if studies do not meet this criterion, we also examine *baseline equivalence* of the final sample used for analysis.

For ***quasi-experimental studies***, since treatment and control groups were not randomized and cannot be assumed to be comparable, evaluators must show that there are no significant differences between the groups included in the analysis on variables related to key outcomes. Thus, for quasi-experimental studies, we examine whether there is *baseline equivalence* of the analytic sample. If a study did not meet the requirements for baseline equivalence of the analytic sample, but could establish baseline equivalence for the initial sample, then it was subject to the *data reduction rate* criterion.

1. Data Reduction Rates

Description. This criterion was assessed for all experimental evaluations and for quasi-experimental designs which only reported baseline equivalence for the baseline sample. Key post-test outcomes are measured for at least 70 percent of the original sample (treatment and comparison groups combined) and differential attrition (i.e., difference between treatment group attrition and comparison group attrition) between groups is less than 15 percentage points.

Justification. Significant sample attrition can bias results, since the participants who drop out of the study may differ from those who remain. It is also important to consider the differential attrition between the treatment and control groups, which can create systematic differences between the groups.

Screening requirements. To pass, the experimental evaluation must meet the conditions described below:

1. Post-test data for 70 percent of original sample; AND
2. Less than 15 percent difference in retained sample between treatment and control groups.

When attrition rates were not provided in the evaluation and data were available, we calculated attrition rates by subtracting the post-test n from the pretest n and dividing by the pretest n.

Results. Three of the nine experimental evaluations passed the data reduction rates criterion and thus were not assessed for baseline equivalence. Projects that passed this criterion reported having low attrition (defined for this report as the retention of at least 70 percent of the original sample), and low differential attrition between the treatment and comparison groups (below 15 percentage points). Two of the experimental evaluations did not pass this criterion, and the remaining four experimental evaluations failed to provide sufficient information to assess this criterion.

Recommendations.

1. Report the number of units of assignment and units of analysis at the beginning and end of the study.
2. If reporting on subgroups, report sample sizes for all subgroups.
3. Implement a plan for keeping sample participants involved with the study. Some successful evaluations reduced attrition by making follow-up data collection as easy as possible: for example, relying on paper tests rather than online surveys (which may be more difficult due to the reliance on respondent initiative and reliable Internet access) or using data from mandatory state tests, virtually guaranteeing follow-up data from all students still enrolled in the state's public schools. Other successful evaluations provided incentives to reduce comparison teacher attrition—monetary payments or promises that comparison teachers could receive professional development in the next program year.

2. Baseline Equivalence

Description. Experimental evaluations with high attrition as well as all quasi-experimental studies must establish baseline equivalence to demonstrate that no significant pre-intervention differences exist between treatment and comparison group participants on variables related to key outcomes. Establishing baseline equivalence ensures that groups have similar background characteristics.

Justification. Experimental evaluations with high attrition and quasi-experimental evaluations with demonstrated baseline equivalence of groups (or QED studies where observed differences have been controlled for in analyses) are considered to be more rigorous. Baseline equivalence suggests that treatment and control groups were drawn from the same population, thus making it less likely that differences between the groups attributed to the interventions have alternative explanations or are due to confounding factors and biases.

Screening requirements. Experimental evaluations with high attrition and quasi-experimental evaluations pass the baseline equivalence criterion when their evaluation design meets at least one of the following two conditions:

1. Tests for and finds no pre-intervention differences between groups on variables related to key outcomes.
2. Tests for and finds limited pre-intervention differences between groups on variables related to key outcomes and controls for baseline differences in the analysis.

Results for Experimental Studies. One of the two experimental evaluations that did not pass the data reduction rates criterion did pass the baseline equivalence criterion. This project demonstrated that there were no significant pre-intervention differences between treatment and comparison group participants on variables related to key outcomes (or accounted for any differences in the analysis).

Results for Quasi-Experimental Studies. Twenty-one quasi-experimental evaluations passed the baseline equivalence criterion of the analytic sample. Evaluations that met the criterion demonstrated that there were no significant pre-intervention differences between treatment and comparison group participants on variables related to key outcomes or accounted for any differences in their analyses.

Eleven quasi-experimental evaluations established baseline equivalence using the baseline sample, but did not provide the information for the analytic sample as required. Of these, none were considered to have passed the criterion. In order to pass, they would have had to establish that the groups were equivalent in the baseline sample *and* attrition was low enough to have met the data reduction rates criterion used for experimental studies (suggesting that the baseline sample was not substantially different from the analytic sample and could stand in as its proxy).

Recommendations.

1. Report key baseline characteristics associated with outcomes for each group, such as pretest scores and teaching experience. Always include sample sizes when reporting statistics.
2. Test for group mean differences on key characteristics with the appropriate statistical test (e.g., chi-square for dichotomous characteristics, t-test for continuous characteristics). Report the test statistics, such as t-statistic or chi-square values.

3. Establish baseline equivalence using the exact sample included in the analyses of impacts. Thus, when reporting baseline equivalence, it would be helpful to only include those participants who are also included in the impact analyses in the tables and inference tests.
4. Conduct analyses on treatment and comparison groups that were comparable at baseline. Some successful evaluations began with data from a pool of potential comparison teachers who did not participate in MSP professional development. For their analysis, they then chose those comparison teachers who most closely matched treatment teachers on key characteristics. Successful evaluations matched treatment and comparison groups on such key characteristics as baseline test scores, school, district, grade level, teachers' years of experience and education, and ability level.

3. Quality of Measurement Instruments

Description. A third crucial component of a rigorous evaluation design is using high quality measures, demonstrated through the use of existing data collection instruments deemed valid and reliable to measure key outcomes; sufficiently pretested data collection instruments developed specifically for the study; or data collection instruments composed of items from a validated and reliable instrument(s).

Justification. Evaluations must use instruments that accurately capture the intended outcomes and which have been tested on a group similar to the one being included in the study.

Screening requirements. All instruments used to measure outcomes must be deemed valid and reliable and have face validity (i.e., appear to measure what they purport to assess).

Results. Eighty-five of the 121 evaluations (70 percent) were measured with an appropriate instrument. The projects that met the criterion used at least one student achievement, teacher content knowledge, teacher pedagogical content knowledge, or classroom practice outcome measure that was widely used or had been previously demonstrated to be reliable and valid (either by the researchers themselves or by others). As seen in Exhibit 35, among the 85 evaluations that passed, 64 (75 percent) used an existing instrument in its entirety. Four evaluations (13 percent) used a full scale from an existing instrument (i.e.., all geometry questions from a mathematics test); and 11 evaluations (13 percent) used selected items from existing instruments. Finally, for 6 evaluations (7 percent), the types of measures used were not clearly described. None of the passing evaluations developed completely new instruments.

Exhibit 35: Percent of Evaluations that Passed the Quality of Measurement Instrument Criterion, by Instrument Creation Method

Instrument Creation Method	Number (Percent) of Passing Evaluations (N=85)
Used full existing instrument	64 (75%)
Used full scale from existing instrument(s)	4 (5)
Used items selected from existing instrument(s)	11 (13)
Not clear	6 (7)
Created all items	0 (0)
Sources: Final evaluation reports, annual performance reports, and related documents	

Recommendations.

1. Use instruments that have been shown to have accurate and consistent scores (i.e., have demonstrated reliability and validity). Where possible, use instruments that have demonstrated reliability and validity for a population similar to the population being studied.

Successful evaluations used a variety of pre-existing assessment, including standardized state tests and test available online in their subject areas.

2. Assessments created for the project must demonstrate validity and reliability using a population similar to respondents in the evaluation. For example, if the focus of the project is upper elementary school teachers, administer a pilot version of the assessment to 5th grade teachers in a school not participating in its program. The pilot results could then be used for assessing the reliability and validity of the instrument.
3. When selecting items from an existing measurement instrument:
    a. Describe previous work that demonstrates that the scores are valid and reliable with a population similar to the current study;
    b. Provide references to the manual or other studies discussing the validity and reliability of scores; and
    c. Use full subscales rather than choosing items from across subscales where possible.

4. Quality of Data Collection Methods

Description. A fourth component of a rigorous evaluation is that the methods, procedures, and time frames used to collect the key outcome data from treatment and comparison groups are the same or similar enough to limit the possibility of observed differences being attributed to a factor other than the intervention.

Justification. Using consistent methods and procedures and collecting data within a similar time frame helps to ensure that observed differences are not attributable to the passage of time or to differences in testing conditions.

Screening requirements. Evaluations pass the data collection methods criterion if evaluators used the same methods, procedures, and time frame to collect data from the treatment and comparison groups. When projects did not specify the data collection procedures used for both groups, which was the case in most evaluations, reviewers assumed data collection methods were the same unless there was reason to believe otherwise.

Results. One hundred seven of the 121 evaluations (88 percent) passed the data collection methods criterion. These projects either reported that the data procedures and timeframes for the intervention and comparison groups were the same, or this was assumed in the absence of contrary reports. Projects that did not pass this criterion reported issues with data collection or differing timeframes for data collection that resulted in the intervention and comparison groups receiving different assessments or having their data collected at different points in time.

Recommendations.

1. Collect data from all members of the treatment and comparison groups for every evaluation. If data cannot be collected from all members of both groups for resource reasons, consider randomly selecting and evaluating a subset of respondents from both the treatment and control group. For example, if the project can support classroom observations of 20 teachers, select 10 from the treatment group and 10 from the comparison group for evaluation.
2. Fully describe and document the data collection procedures, and if there are differences in the data collection methods, describe those differences fully and explain how they may, or may not, have affected the evaluation. For example, in some cases Treatment teachers were assessed in the summer, directly before and after a summer institute, and Comparison teachers were tested before the beginning of summer, and at the start of the new school year. Evaluators may make the argument that those time periods are equivalent in terms of the intervention.

5. Relevant Statics Reported

Description. The final component of our review required final reports to include treatment and comparison group post-test means and tests of statistical significance for key outcomes *or* sufficient information for calculation of statistical significance (e.g., mean, sample size, standard deviation/ standard error).

Justification. Reporting relevant statistics provides critical context for interpreting the reported outcomes and indicates where an observed difference is larger than what would likely be created by chance.

Screening requirements. An evaluation passes if either of the following conditions is met:

4.1. Post-test means and test of significance for key outcomes are included in the evaluation.

4.2. Evaluation provides sufficient information to calculate statistical significance (e.g., reports of mean, sample size, standard deviations/standard error).

Results. Seventy-seven of the 121 evaluations (64 percent) passed the relevant statistics reported criterion. These evaluations included post-test treatment and comparison group means and tests of statistical significance for key outcomes in their reports; or provided information that could be used to derive them.

Recommendations.

1. For each evaluation, report means, standard deviations (or errors), and sample size. If reporting a regression model or ANOVA analysis, report the model statistics *and* means and standard deviations (or error).
2. Report the appropriate test for differences between groups. Successful evaluations reported data in a variety of ways. For example, an evaluation with continuous gain scores on a standardized assessment reported t-tests and p-values for each of their findings. Another evaluation with a regression model of continuous outcome scores (controlling for baseline scores), reported coefficients and p-values. Those using ANOVA reported both the F-test statistic and the associated p-values.

Summary

As one of the goals of the MSP program is to assist projects in providing high-quality information on program outcomes, criteria were developed to guide projects in implementing and evaluating rigorous impact evaluations. This rubric is shared with all MSP projects and their evaluators and is described during annual regional meetings. Additionally, technical assistance to help projects meet the rubric's standards is provided upon request.

While we recognize that not all projects are at the stage where rigorous designs are appropriate, particularly those that are still developing and testing hypotheses, the standards presented in the rubric are relevant to all evaluations, whether as guidance for future designs or for assessing current ones. A summary of the criteria passed in PP09 is helpful for understanding which elements of the rubric future projects may need additional guidance on when implementing their evaluations. Exhibit 36 indicates that evaluations were most likely to meet the criterion for *quality of the data collection methods* (88 percent of the evaluations), followed by *quality of the measurement instruments* (70 percent of the evaluations). However, less than two-thirds of the evaluations (64 percent) passed the *relevant statistics reported* criterion, suggesting that more training is needed on the quantitative information that should be included in evaluation reports.

Projects had more difficulty meeting the *data reduction rates* criterion, with only one-third of experimental studies passing.[31] Quasi-experimental studies were not subject to this criterion unless they did not provide the baseline equivalence of the analytic sample (and only demonstrated baseline equivalence of the initial sample), and among those that were assessed, none passed this criterion. Keeping teachers in the study and collecting post-test data from all participants is a challenge many projects report. Finally, fewer than one-fifth of evaluations (18 percent) passed the criterion for *baseline equivalence*. This is not surprising given that many projects reported having difficulty identifying appropriate comparison groups, particularly projects in rural locations. Most experimental studies were not subject to this criterion, since the random assignment of participants to groups in these studies helps to ensure the similarity of groups, which was usually preserved unless there was significant attrition.

[31] If experimental studies did not meet this criterion, they could still pass the rubric if they met the baseline equivalence criterion.

Exhibit 36: Number and Percent of Evaluations that Met Each Criterion for Rigorous Research Design, Performance Period 2009

Rubric Criterion	Number (Percent) of Evaluations		
	Experimental Study N=9	Quasi-Experimental Study with a Comparison Group N=112	Total N=121
Data reduction rates	3 (33%)	NA	3 (33%)
Baseline equivalence	1 (11)	21 (19%)	22 (18)
Quality of the measurement instruments	7 (78)	78 (70)	85 (70)
Quality of the data collection methods	8 (89)	99 (88)	107 (88)
Relevant statistics reported	5 (56)	72 (64)	77 (64)
Met all rubric criteria	4 (44)	16 (14)	20 (17)

Sources: Final evaluation reports, annual performance reports, and related documents submitted by MSP projects.

Finally, as Exhibit 36 indicates, the number of projects implementing comparison group designs increased from 37 in PP07, to 49 in PP08, to 65 in PP09. Similarly, the number of projects with at least one evaluation passing all rubric criteria increased four-fold from PP07 to PP09.

In the past three years, there have been substantial increases in the number of projects attempting to implement comparison group designs and in those implementing them successfully.

While part of this difference can be attributed to a change in the criteria used to assess final-year evaluations in PP09,[32] the larger difference is due to the fact that more projects implemented more rigorous evaluation designs.

Exhibit 36: Number of Projects that Implemented Comparison Group Designs and Met all Rubric Criteria, Performance Periods 2007–2009

Projects	PP07	PP08	PP09
Implemented comparison group designs	37	49	65
Included at least one evaluation that passed all rubric criteria	4	3	16

[32] Eleven of the sixteen PP09 passing projects would have passed the sample size criterion that was included in previous year and removed for PP09 (in an effort to more closely align the criteria to the review standards used by the What Works Clearinghouse). One additional project may also have passed this criterion, but they did not provide sufficient information to make a determination.

Local projects face many challenges in implementing rigorous designs, including such issues as limited resources, difficulties identifying reasonable comparison groups, and difficulties keeping all participants in the study and collecting their data. Additionally, local projects often lack evaluation expertise. Yet in an environment where there is greater attention being paid to the quality of research evidence, it has become increasingly important to support projects in implementing designs that are able to determine the effectiveness of their interventions. The MSP Program has been educating its projects about rigorous evaluation designs by providing them with criteria for carrying out effective impact evaluations. This has led to an increasing number of projects attempting to implement rigorous designs and more projects implementing them successfully.

Appendix B: Criteria for Classifying Designs of MSP Evaluations

This appendix includes the *Criteria for Classifying Designs of MSP Evaluations* used to determine the number of projects that successfully conducted rigorous evaluations. The criteria were developed as part of the Data Quality Initiative (DQI) through the Institute for Education Sciences (IES) at the U.S. Department of Education. The results of the review of final year MSP projects according to these criteria are presented in Appendix C.

Criteria for Classifying Designs of MSP Evaluations

- ❒ **Experimental study—**the study measures the intervention's effect by randomly assigning individuals (or other units, such as classrooms or schools) to a group that participated in the intervention, or to a control group that did not; and then compares post-intervention outcomes for the two groups

- ❒ **Quasi-experimental study—**the study measures the intervention's effect by comparing post-intervention outcomes for treatment participants with outcomes for a comparison group (that was not exposed to the intervention), chosen through methods other than random assignment. For example:

  - *Comparison-group study with equating*—a study in which statistical controls and/or matching techniques are used to make the treatment and comparison groups similar in their pre-intervention characteristics

  - *Regression-discontinuity study*—a study in which individuals (or other units, such as classrooms or schools) are assigned to treatment or comparison groups on the basis of a "cutoff" score on a pre-intervention non-dichotomous measure

Criteria for Assessing whether Experimental and Quasi-experimental Designs Were Conducted Successfully and Yielded Scientifically Valid Results

A. Data Reduction Rates (i.e. Attrition Rates, Response Rates)[33]

❒ **Met the criterion**. Key post-test outcomes were measured for at least 70 percent of the original sample (treatment and comparison groups combined) and differential attrition (i.e., difference between treatment group attrition and comparison group attrition) between groups was less than 15 percentage points.

❒ **Did not meet the criterion**. Key post-test outcomes was measured for less than 70 percent of the original sample (treatment and comparison groups combined) and/or differential attrition (i.e., difference between treatment group attrition and comparison group attrition) between groups was 15 percentage points or higher.

❒ **Not applicable.** This criterion was not applicable to quasi-experimental designs unless it was required for use in establishing baseline equivalence (see the *Baseline Equivalence of Groups* criterion below).

B. Baseline Equivalence of Groups

❒ **Met the criterion (quasi-experimental studies).** There were no significant pre-intervention differences between treatment and comparison group participants in the analytic sample on the outcomes studied, or on variables related to the study's key outcomes.

- The mean difference in the baseline measures was less than or equal to five percent of the pooled sample standard deviation; *or*

- The mean difference in the baseline measures was more than five percent but less than or equal to twenty-five percent of the pooled sample standard deviation, and the differences were adjust for in analyses (e.g., by controlling for the baseline measure).

- If the data required for establishing baseline equivalence in the analytic sample were missing (and there was evidence that equivalence was tested), then baseline equivalence could have been established in the baseline sample *providing the data reduction rates criterion above was met.*

❒ **Met the criterion (experimental evaluations that did not meet the data reduction rates criterion above).** There were no significant pre-intervention differences between treatment and comparison group participants in the analytic sample on the outcomes studied, or on variables related to the study's key outcomes.

[33] The data reduction and baseline equivalent criteria were adapted from the What Works Clearinghouse standards (see http://ies.ed.gov/ncee/wwc/pdf/wwc_procedures_v2_standards_handbook.pdf).

- ❒ **Did not meet the criterion.** Baseline equivalence between groups in a quasi-experimental design was not established (i.e. one of the following conditions was met):
  A. Baseline differences between groups exceeded the allowable limits; *or*
  B. The statistical adjustments required to account for baseline differences were not conducted in analyses; *or*
  C. Baseline equivalence was not examined or reported in a quasi-experimental evaluation (or an experimental evaluation that did not meet the data reduction rates criterion above).

- ❒ **Not applicable.** This criterion was not applicable to experimental designs that met the data reduction rates criterion above.

C. Quality of the Measurement Instruments

- ❒ **Met the criterion**—the study used existing data collection instruments that had already been deemed valid and reliable to measure key outcomes; or data collection instruments developed specifically for the study were sufficiently pre-tested with subjects who were comparable to the study sample

- ❒ **Did not meet the criterion**—the key data collection instruments used in the evaluation lacked evidence of validity and reliability

- ❒ **Did not address the criterion**

D. Quality of the Data Collection Methods

- ❒ **Met the criterion**—the methods, procedures, and timeframes used to collect the key outcome data from treatment and control groups were the same

- ❒ **Did not meet the criterion**—instruments/assessments were administered differently in manner and/or at different times to treatment and control group participants

E. Relevant Statistics Reported

- ❒ **Met the criterion**—the final report includes treatment and control group post-test means, and tests of statistical significance for key outcomes; or provides sufficient information for calculation of statistical significance (e.g., mean, sample size, standard deviation/standard error)

- ❒ **Did not meet the criterion**—the final report does not include treatment and control group post-test means, and/or tests of statistical significance for key outcomes; or provide sufficient information for calculation of statistical significance (e.g., mean, sample size, standard deviation/standard error)

- ❒ **Did not address the criterion**

Appendix C: 2009 State MSP Appropriations

MSP appropriations to states ranged from $890,416 up to $20,037,656, with an average of $3,180,056 and a median of $1,943,866.

Exhibit C.1: MSP Appropriations to the States

State	Total Funding Amount	State	Total Funding Amount
AK	$890,416	MT	$890,416
AL	$3,293,677	NC	$5,188,797
AR	$2,137,830	ND	$890,416
AZ	$3,954,015	NE	$890,416
CA	$20,037,656	NH	$890,416
CO	$2,164,079	NJ	$2,908,426
CT	$1,104,970	NM	$1,481,848
DC	$890,416	NV	$1,169,537
DE	$890,416	NY	$10,864,164
FL	$8,241,593	OH	$6,098,332
GA	$6,001,369	OK	$2,298,304
HI	$890,416	OR	$1,733,440
IA	$1,101,745	PA	$5,536,748
ID	$890,416	PR	$7,351,085
IL	$6,574,304	RI	$890,416
IN	$3,137,163	SC	$2,695,869
KS	$1,153,093	SD	$890,416
KY	$2,811,500	TN	$3,890,372
LA	$3,603,480	TX	$18,111,705
MA	$2,387,083	UT	$1,053,000
MD	$1,746,187	VA	$2,877,236
ME	$890,416	VT	$890,416
MI	$5,821,453	WA	$2,674,768
MN	$1,749,902	WI	$2,273,620
MO	$3,032,996	WV	$1,063,654
MS	$2,730,622	WY	$890,416