Mathematics and Science Partnerships: Summary of Performance Period 2010 Annual Reports

Analytic and Technical Support for Mathematics and Science Partnerships

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Prepared for

Patricia O'Connell Johnson
Valerie Randall
U.S. Department of Education,
400 Maryland Ave, SW
Washington, DC 20208

Prepared by

Abt Associates Inc.
Ellen Bobronnikov
Nathaniel Donoghue
Meenakshi Fernandes
Simone Fried
Elizabeth Giardino
Rebecca Gotlieb
Jackie Mendez
Sarah Sahni

150 Wheeler Street
Cambridge, MA 0213

Report Title

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Executive Summary

Improving students' achievement in mathematics and science will be critical to maintaining the nation's competitiveness. Research on teacher quality has demonstrated that one of the strongest indicators of students' academic success is the competence and capability of their teachers (Clotfelder, Ladd, and Vigdor, 2007; Hanushek and Rivkin, 2010; Hill, Rowan, and Ball, 2005; Rivkin, Hanushek, and Kain, 2005). 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 collaborative partnerships between high-need school districts[1] 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, ranging from $150 to $182 million awarded to local partnerships each year. In FY 2010, grants to states totaled $150 million in funds.

Performance Period 2010 Mathematics and Science Partnerships

This report presents an overview of the MSP program during Performance Period 2010 (PP10),[2] 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 PP10, federal MSP resources totaling $150 million were distributed to the 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.[3] State grants ranged from approximately $745,000 up to nearly $18 million with an average of $2.8 million and a median of $1.7 million. In turn, the states funded a total of 566 local MSP projects, with local grants ranging from approximately $30,000 to

[1] 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.

[2] Performance Period 2010 (PP10) refers to the period between October 1, 2010 and September 30, 2011.

[3] 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.

nearly $800,000 with a median project grant of $210,000 and a mean of nearly $316,000. As shown in Exhibit ES.1, most projects (86 percent) received $500,000 or less in funding. In addition to 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 2010

Project Budgets	Percent of Projects (N=566)
$100,000 or less	12%
$100,001 to $200,000	36
$200,001 to $500,000	37
$500,001 to $1,000,000	12
$1,000,001 or more	3

Source: Annual Performance Report item I.A.6
The non-response rate was <1 percent in PP10.

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 (87 percent) in PP10 targeted individual teachers in their professional development interventions. The remaining 13 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

Over three thousand faculty members from institutions of higher education (IHEs) were involved with MSP projects in PP10, with an average of 6 IHE faculty members per project. Projects are required to establish direct interactions between K-12 teachers 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 44,000 elementary, middle, and high school teachers, coaches, paraprofessionals, and administrators participated in MSP projects in PP10. The number of these participants served by individual MSP projects ranged widely from 5 to 1,200, with typical projects serving slightly over 40 participants. These participants, in turn, taught over 2.1 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 PP10, nearly four-fifths of projects (78 percent) targeted multiple school levels (i.e.,

[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); 46 percent served participants from all three school levels. Among the individuals participating in MSP activities, 52 percent were employed at the elementary school level, 28 percent were at the middle school level, and the remaining 20 percent were at the high school level.

Professional Development Content, Models, and Activities

Professional Development Content

In PP10, 31 percent of MSP projects provided professional development in both mathematics and science; 38 percent provided professional development in mathematics only; and 31 percent provided professional development in science only.

Most MSP projects addressed multiple content areas and topics, both within and across disciplines. Across elementary, middle, and high schools, scientific inquiry was the most frequently addressed science topic (91 to 93 percent of projects that addressed science), and chemistry was the least frequently addressed science topic (45 to 51 percent). In mathematics, problem solving was among the most frequently addressed content areas (82 to 84 percent of projects that addressed mathematics), and calculus was the least frequently addressed topic (4 to 19 percent of projects that addressed mathematics).

Professional Development Models

As shown in Exhibit ES.2, nearly half of projects (49 percent) conducted summer institutes with school-year follow-up activities.[5] These projects reported offering a median of 100 hours of professional development. Just 2 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: Median Professional Development Hours, by Professional Development Model Type, Performance Period 2010

Professional Development Model	Percent of Projects (N=566)	Total Median Hours
Summer institute only	2%	80
Summer institute with follow-up	49	100
Focus on school-year activities[1]	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 0 percent:
[1] 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

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

most commonly reported model for delivering school-year activities was on-site professional development (62 percent of projects), followed by study groups (16 percent), content coursework at colleges or universities (12 percent), conferences (4 percent) and on-line coursework/distance learning networks (2 percent). In addition, four percent of projects specified other professional development activities.

MSP Evaluation Designs and Outcomes

Evaluation Designs

MSP projects reported the primary designs they used to assess program outcomes. Two percent reported using an experimental design in which teachers, classrooms, or schools were randomly assigned to a treatment or control group. Another 45 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 (38 percent); qualitative or descriptive methods only (12 percent); or mixed quantitative and qualitative methods (3 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 projects with at least one evaluation passing all rubric criteria increased four-fold from PP07 to PP09. While the number decreased slightly in PP10, among projects that implemented comparison group designs, the fraction that met all rubric criteria remained the same between PP09 and PP10 (25 percent). The rate at which projects implemented rigorous evaluation designs was maintained in PP10.

The MSP program has been educating its projects by providing them with criteria for carrying out rigorous 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 and Percent of Final-Year Projects that Implemented Comparison Group Designs and Met all Rubric Criteria, Performance Periods 2007–2010

Projects	PP07	PP08	PP09	PP10
Implemented comparison group designs	37	49	65	59
Included at least one evaluation that passed all rubric criteria	4	3	16	15
Percent of projects with at least one passing evaluation	11%	6%	25%	25%

Teacher Content Knowledge Outcomes

As shown in Exhibit ES.4, over half of teachers who received professional development in mathematics and science were tested using pre- and post-assessments in PP10 (53 percent in mathematics and 60 percent in science). Nearly two-thirds of teachers who were assessed in mathematics (65 percent) and nearly three-quarters of teachers who were assessed in science (74 percent) showed statistically significant gains in their content knowledge.

The most frequently reported assessments of teacher content knowledge in mathematics were nationally normed/standardized tests (66 percent of projects). Projects that did not use nationally normed or standardized content assessments often developed their own assessments for their MSP projects. Nearly 40 percent used locally developed tests to assess teacher gains in mathematics content knowledge. In science, the most frequently used instruments were locally developed tests (55 percent of projects), followed by standardized instruments (44 percent).

Exhibit ES.4: Percent of Teachers with Significant Gains in Content Knowledge, Among Teachers with Pre-Post Content Assessments, Performance Period 2010

Content Area	Total Number of Teachers Served	Percent of Teachers with Content Assessments	Percent of Assessed Teachers with Significant Gains
Mathematics	25,344	53%	65%
Science	19,562	60	74

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.

Student Achievement Outcomes

As shown in Exhibit ES.5, among the 64 percent of students with assessment data in mathematics, nearly two-thirds (65 percent) scored at the proficient level or above. Similarly, among the 39 percent of students with assessment data in science, 67 percent scored at the proficient level or above. These levels represent substantial increases from earlier 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 PP10, in both mathematics and science, approximately 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 2010

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	1,280,438	64%	65%
Science	903,788	39	67

Source: Annual Performance Report items VIII.B. 1, 2, 3, 4, 5, 6, 7, 8
Students who are taught by teachers receiving professional development in math and science may be double counted.

In PP10, almost all MSP projects (92 percent) that measured student achievement in mathematics used state assessments; however, in science, only half of projects (54 percent) that measured student achievement in science used state assessments. Projects commonly reported utilizing locally developed tests (47 percent) in science.

Conclusions

In PP10, nearly 6,200 local educational agencies (LEAs), organizations, and institutions—involving 3,290 IHE faculty members—partnered to form 566 projects across the country. Projects served close to 44,000 educators nationwide, with each educator receiving an average of 82 hours of professional development, thus enhancing the quality of classroom instruction for over 2.1 million students.

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.

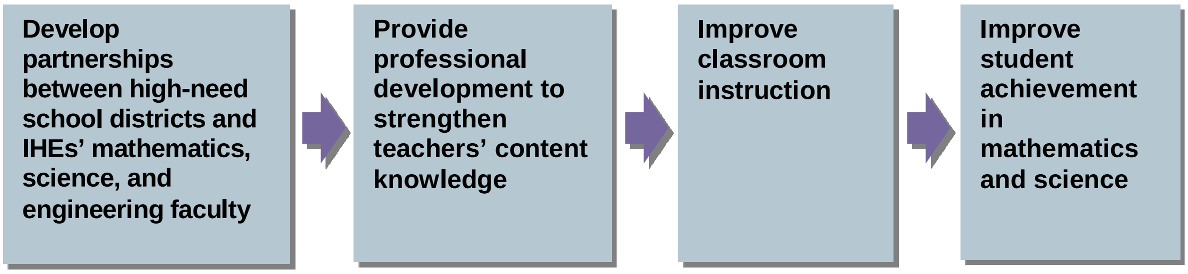
Based on this professional development, 65 percent of teachers who were assessed in mathematics and 74 of teachers who were assessed in science showed statistically significant gains in their content knowledge. Approximately two-thirds of students taught by MSP teachers scored proficient at the proficient level or above in state assessments in mathematics or science.

Chapter 1: Introduction

Improving students' achievement in mathematics and science will be critical to maintaining the nation's competitiveness. Research on teacher quality has demonstrated that one of the strongest indicators of students' academic success is the competence and capability of their teachers (Clotfelder, Ladd, and Vigdor, 2007; Hanushek and Rivkin, 2010; Hill, Rowan, and Ball, 2005; Rivkin, Hanushek, and Kain, 2005). 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 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



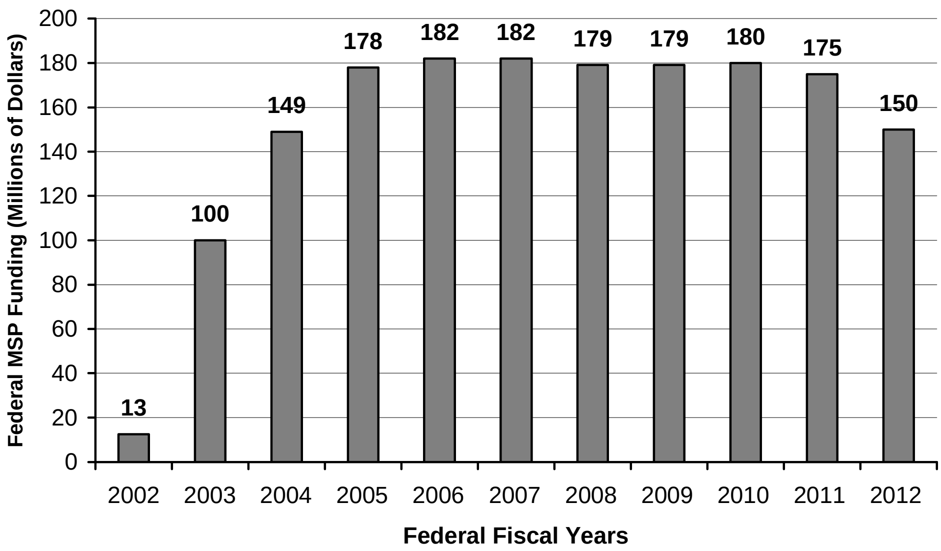
The Mathematics and Science Partnership Program

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[6] and science, technology, engineering, and mathematics departments in institutions of higher education.

[6] 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 2010, the period described in this report, states awarded $150 million in funds to 566 local partnerships (projects) that collectively provided professional development services to an estimated total of over 43,000 teachers. Moreover, many projects trained teacher leaders, who then provided additional training to other teachers in their schools and districts.[7]

Exhibit 2: MSP Program Funding, Fiscal Years 2002–2012



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 aged 5 through 17 years old in the state 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. [8]

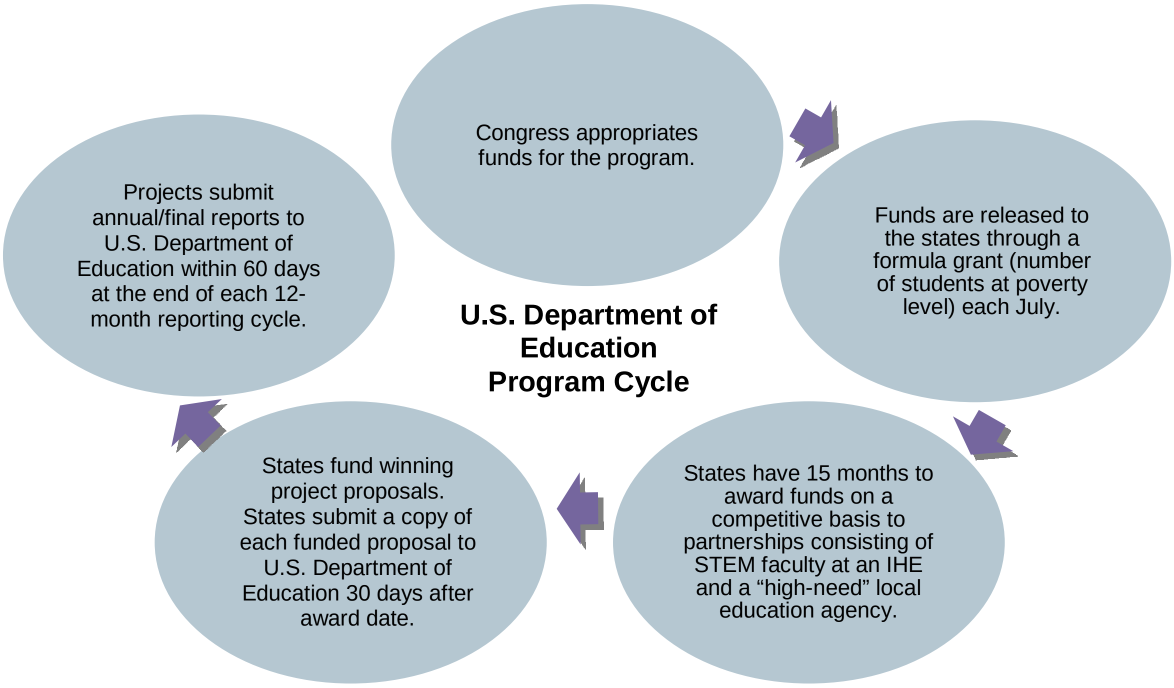
States have 15 months (through September 30 of the following year) to manage competitions and award their funds to projects (Exhibit 3). MSP sub-grants may be funded for up to three years. The law also requires all MSP projects report annually to the U.S. Department of Education. Projects

7 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.

8 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 2010 (PP10).[9] The findings presented in this report are primarily based on annual performance report (APR) data submitted by all MSP projects by February 29, 2012.[10] Additionally, to examine trends in the MSP program over time, data from previous years are also included for some APR items. The report

9 Performance Period 2010 (PP10) refers to the period between October 1, 2010 and September 30, 2011. PP10 projects are those for which the majority of months of activities described in the Annual Performance Report take place in the 2010 fiscal year, between October 1, 2010 and September 30, 2011.

10 These primarily included PP10 reports, but they also included some PP09 reports for which teacher and/or student data were not available in time to submit during the previous year.

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 in 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?

Report Organization

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

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 MSP, 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 2010 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 PP10, federal MSP resources totaling $150 million were distributed through formula grants to all 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.[11] No state received less than one half of one percent of the total appropriation; MSP appropriations to individual states ranged from $744,840 to $17.9 million. See Appendix C for the specific MSP appropriation to each state.

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 awards ranged from $30,265 to $7.8 million with an average of $315,886 and a median of $210,000. As shown in Exhibit 5, over three-fourths of projects (77 to 86 percent) received an award of $500,000 or less between PP04 andPP10. The size of awards in PP10 has continued the trend seen in recent years, with most projects receiving awards between $100,000 and $500,000, and fewer projects receiving either smaller or larger awards.

Exhibit 5: MSP Awards from State MSP Grants, Performance Periods 2004–2010

MSP Awards	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)	PP10 Percent of Projects (N= 566)
$100,000 or less	22%	20%	17%	9%	13%	13%	12%
$100,001 to $200,000	23	29	37	43	38	37	36
$200,001 to $500,000	32	32	26	26	30	36	37
$500,001 to $1,000,000	17	14	15	18	17	13	12
$1,000,001 or more	6	5	5	4	2	1	3

Source: Annual Performance Report item I.A.6

The non-response rate[12] was 7 percent in PP04, 9 percent in PP05, 1 percent in PP06, <1 percent in PP07, 0 percent in PP08, <1 percent in PP09, and 0 percent in PP10.

[11] 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.

[12] 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).

Some MSP projects supplemented their federal MSP funds with funds from other federal and non-federal sources. In PP10, 16 percent of projects reported receiving funds from other sources. These additional funds ranged from $1,000 to $2.7 million.

Organization and Partnerships

Each MSP grant has a lead organization that serves as the designated fiscal agent for the project. The lead organization 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 PP07, over half of all projects (between 53 and 56 percent) had local school districts serve as fiscal agents, while fewer than one-third of projects (between 29 and 31 percent) had IHEs fulfill this role. Over the past few years, the responsibility for lead organization has begun shifting back toward a more even split between the school districts and IHEs, but with more school districts continuing to take the lead role. The remaining projects indicated that neither local school districts nor IHEs served as the lead organization. In PP10, other designated fiscal agents for the projects primarily included regional organizations (12 percent) and non-profit organizations (4 percent).

Exhibit 6: Types of Lead Organizations, Performance Periods 2004–2010

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)	PP10 Percent of Projects (N=566)
Local school district	41%	54%	53%	56%	50%	47%	44%
Institution of higher education (IHE)	44	29	31	31	37	35	39
Non-profits, regional educational agencies, or other organizations	15	17	16	13	13	18	17

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, 0 percent in PP09, and 0 percent in PP10.

The MSP program establishes local partnerships that include: 1) a science,[13] 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

[13] Computer science is included with science departments.

mathematics and science teachers. MSP projects reporting in PP10 had an average of 10 partner organizations, with the number of partners ranging from 1 to 309.

In PP10, 3,290 IHE faculty members, working in a variety of disciplines, were involved with MSP projects. As shown in Exhibit 7, 60 percent or more of all projects included faculty from science (60 percent) or mathematics (63 percent) departments, and 12 percent of projects included faculty from engineering departments. Additionally, approximately two-thirds of the projects (66 percent) reported working with faculty members from education departments, and 13 percent of projects included faculty from "other" departments, such as business, psychology, and health, as well as individuals associated with IHEs in a capacity other than teaching faculty, such as deans, administrators, district services, K–12 outreach staff, and consultants. On average, 6 IHE faculty members participated per project, from multiple disciplines.

Exhibit 7: Disciplinary Affiliation of IHE Faculty Participating in MSP, Performance Period 2010

Discipline	Percent of Projects (N=566)	Average Number per Project, Among Projects with Participating Faculty	Total Number Participating in MSP (Sum=3,290)
Science[1]	60%	3	1,125
Mathematics	63	3	936
Engineering	12	3	187
Education	66	2	883
Other	13	2	159

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 0 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 PP10, more projects reported being fully developed or developing than new (50 percent, 34 percent, and 16 percent of projects respectively). This trend is in keeping 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 2008–2010

Stage of Implementation	PP08 Percent of Projects (N=626)	PP09 Percent of Projects (N=588)	PP10 Percent of Projects (N=566)
Stage 1: New	15%	17%	16%
Stage 2: Developing	40	36	34
Stage 3: Fully Developed	45	47	50

Source: Annual Performance Report item VII.C
The non-response rate was 0 percent in PP08, <1 percent in PP09, and 0 percent in PP10.

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 44,000 participants in PP10, including elementary, middle, and high school teachers, coaches, paraprofessionals, and administrators (Exhibit 9). This number represents a decrease in the number of participants served from previous years. However, the median number of participants served per project has remained stable over the years.[14] The number of participants reported by individual projects varied widely, ranging from a minimum of 5 participants to a maximum of 1,200. Nearly all projects (93 percent) worked with 200 participants or fewer. Well over half of the projects (59 percent) reported serving 50 or fewer participants in PP10; 24 percent reported serving between 50 and 100 participants; and the remaining projects (17 percent) reported serving more than 100 participants.

[14] A median of 41 means that half of reporting MSP projects served 41 or fewer participants, and half served more than 41 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.

Exhibit 9: Distribution and Statistics Regarding Total Number of Participants Served by MSP Projects, Performance Periods 2008–2010

Number of Participants Served	PP08 (N=595)	PP09 (N=585)	PP10 (N=565)
Total number served by MSP projects	57,639	48,950	43,755
Median number served per project	43	42	41
Minimum number served per project	4	6	5
Maximum number served per project	3,944	1,423	1,200
25 or fewer	21%	20%	20%
26-50	36	42	39
51-100	22	20	24
101-200	11	10	10
201 or more	10	8	7

Source: Annual Performance Report items IV.C, IV.G.1
The non-response rate was 5 percent in PP08, <1 percent in PP09, and <1 percent in PP10.

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 (87 percent) in PP10 targeted individual teachers in their professional development interventions. The remaining 13 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 (99 percent), with only a few serving private, charter, or other types of schools (1 percent). More than half of these schools (56 percent) had schoolwide Title I status; and 64 percent had over 40 percent of students who were receiving free or reduced price lunch. In addition, 44 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 2010

Primary Target	Percent of Projects (N=566)
Individual teacher	87%
Schools (one school, schools within a district, or schools across district lines)	13%

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

Two-thirds of projects (67 percent) indicated that the main goal of their MSP project was to improve individual teachers' content knowledge, while only 4 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 2010

Main Goal	Percent of Projects (N=565)
Improving teachers' content knowledge	67%
Training teacher leaders	4
Both	27
Other	2

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

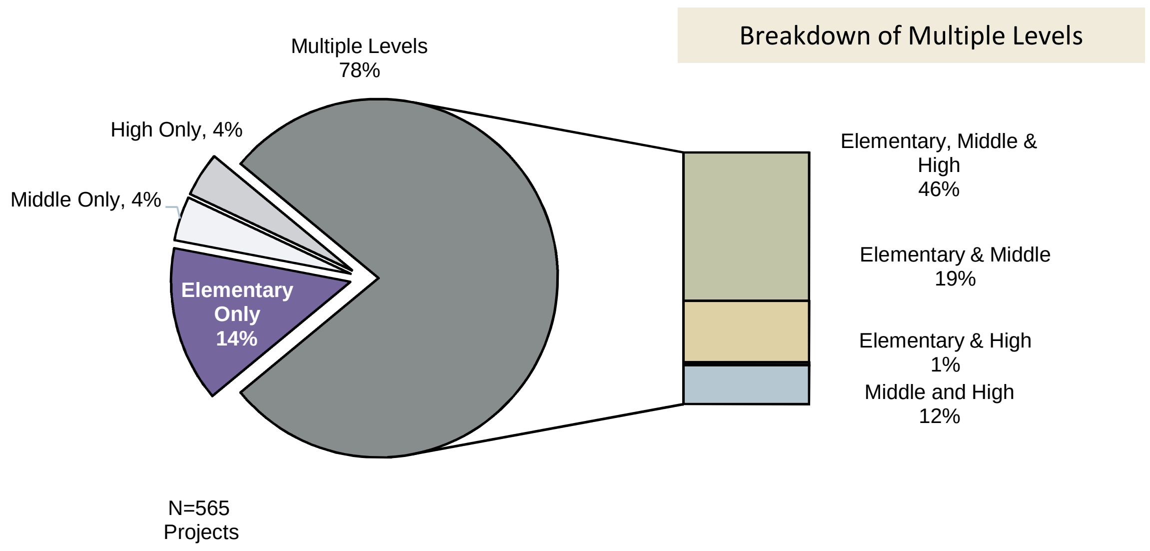
School Levels and Types of Participants Served

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 PP10, 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, 14 percent of all MSP projects in PP10 targeted the elementary school level only, 4 percent targeted the middle school level only, and 4 percent targeted the high school level only. The remaining 78 percent of projects targeted multiple school levels. Forty-six percent of projects targeted participants at all school levels; 19 percent targeted elementary and middle school participants; 12 percent targeted middle and high school; and 1 percent targeted elementary and high school. Although the majority of projects served multiple school levels, more than half of participants who participated in MSP projects (52 percent) were from elementary schools.

MSP participants were distributed across school levels in PP10 as follows: 52 percent at the elementary level, 28 percent at the middle school level, and 20 percent at the high school level. This distribution has remained fairly stable over recent years.

Exhibit 12: School Levels of Participants Served, Performance Period 2010



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 13 examines the different types of educators participating in MSP projects and shows the total proportion of each participant type served by school level.

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. At each school level, nearly 85 percent of teachers were regular core content teachers. 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.

The next two largest groups of MSP participants across school levels were special education teachers (between 5 and 6 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 2010

Participant Type	Percent of Teachers and Other School Staff Served		
	Elementary School (K–5) (N=22,277)	Middle School (6–8) (N=12,028)	High School (9–12) (N=8,776)
Regular core content	84%	84%	85%
Special education teachers	5	6	5
School administrators	5	4	5
Math coaches	2	1	1
Science coaches	1	1	<1
ELL	2	2	1
Gifted and talented / AP-IB	1	2	3
Paraprofessionals	<1	<1	<1

Source: Annual Performance Report items IV.D, E, F, G
The non-response rate was 0 percent.
Administrators who received professional development are not included in this exhibit.

In total, MSP projects reported reaching over 2 million students in PP10. Exhibit 14 shows the total number of students at each school level who were taught by MSP participants, as well as the median,[15] minimum, and maximum number of students reached by MSP participants.

Exhibit 14: Total Number of Students Taught by Participants in MSP Projects, Performance Period 2010

Number of Students Taught	Elementary School (N=433 Projects)	Middle School (N=438 Projects)	High School (N=336 Projects)
Total number taught by MSP participants	591,973	914,051	633,565
Median number taught per project	675	1,059	988
Minimum number taught per project	5	3	10
Maximum number taught per project	22,800	43,050	21,400

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

15 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 PP10, 38 percent of projects focused on mathematics only, 31 percent focused on science only, and 31 percent focused on both mathematics and science. This trend has remained fairly stable over time.

Exhibit 15: Content Focus of Professional Development, Performance Periods 2008–2010

Content Focus	PP08 Percent of Projects (N=619)	PP09 Percent of Projects (N=581)	PP10 Percent of Projects (N=565)
Mathematics only	37%	39%	38%
Science only	31	30	31
Mathematics and science	32	31	31

Source: Annual Performance Report items VI.A.1, VI.B.1
The non-response rate was 1 percent in PP08, 1 percent in PP09, and 0 percent in PP10.

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 (82 to 84 percent of projects), and calculus was the least frequently addressed topic (4 to 19 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 algebra, measurement, or technology; over half of projects addressed geometry or reasoning and proof; and 40 percent of projects addressed probability and statistics.

At the middle school level, 82 percent of 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, 61 percent of projects addressed technology and over half of projects addressed geometry, reasoning and proof, or measurement. At the high school level, over three-fourths of projects that involved math professional development addressed problem solving or algebra as one of their content areas, and two-thirds of projects addressed technology. Sixty-two percent of projects addressed number and operations. Additionally, over half of projects addressed geometry, probability and statistics, or reasoning and proof, and just under half of projects addressed measurement. Finally, 19 percent of projects addressed calculus.

Exhibit 16: Content Areas and Processes of Mathematics Professional Development Provided to Teachers, by School Level, Performance Period 2010

Mathematics Content and Processes	Elementary School Teachers Percent of Projects (N=297)	Middle School Teachers Percent of Projects (N=296)	High School Teachers Percent of Projects (N=224)
Problem solving	84	82	82
Number and operations	82	70	62
Algebra	65	78	77
Geometry	53	56	59
Measurement	58	53	49
Probability and statistics	40	45	50
Reasoning and proof	50	55	55
Calculus	4	7	19
Technology	56	61	67
Other	16	18	19

Source: Annual Performance Report item VI.A.2

The total number of projects that provided professional development in mathematics content areas or processes in PP10 was 387. The non-response rate was 0 percent in PP10.

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 (91 to 93 percent of projects), and chemistry was the least frequently addressed topic (45 to 51 percent). Many projects (68 to 70 percent) across school levels provided professional development in technology.

At the elementary school level, 93 percent of projects that involved science professional development addressed scientific inquiry. Additionally, approximately two-thirds of projects addressed technology, life science or physical science; and fewer than 60 percent of projects addressed earth science. Forty-five percent of projects serving elementary school teachers provided professional development in chemistry.

At the middle school level, 93 percent of projects that involved science professional development addressed scientific inquiry. In addition, approximately two-thirds of projects addressed physical science/physics, life science or technology, and 60 percent addressed earth science. Just over half of projects serving middle school teachers provided professional development in chemistry.

At the high school level, 91 percent of projects that involved science professional development addressed scientific inquiry, between 60 and 70 percent of projects addressed physical science/physics, life science or technology, and nearly 50 percent of projects addressed earth science or chemistry.

Exhibit 17: Content Areas and Processes of Science Professional Development Provided to Teachers, by School Level, Performance Period 2010

Science Content Areas and Processes	Elementary School Teachers Percent of Projects (N=269)	Middle School Teachers Percent of Projects (N=276)	High School Teachers Percent of Projects (N=194)
Scientific inquiry	93%	93%	91%
Physical science/Physics	65	67	61
Life science/Biology	66	67	67
Earth science	59	60	48
Chemistry	45	51	48
Technology	68	70	70
Other	31	27	32

Source: Annual Performance Report item VI.B.2

The total number of projects that provided professional development in science content areas or processes in PP10 was 353. 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 intensive learning experiences over a minimum of a two-week period.[16] Although improving teacher content knowledge directly through a summer institute with in-school follow-up is the most common model of MSP professional development, nearly half of projects focus their efforts on school-year activities.

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

Projects with Summer Institutes

In PP10, approximately half of MSP projects (51 percent) conducted a summer institute. These learning experiences include deep exploration of mathematics and science content. Projects that offer summer institutes typically follow-up activities during the academic year, with the aim of enhancing or extending the knowledge gained by participants over the summer. Nearly all of the projects that offered summer institutes also conducted follow-up activities. As shown in Exhibit 18, in PP10, 49 percent of projects conducted summer institutes with school year follow-up activities, while only 2 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.

> In Arkansas, the Science Lead Teacher Institute (SLTI) provided a two-week summer institute with follow-up activities. Summer institute sessions were content-intensive, classroom-focused, and aligned with state standards. STEM faculty provided all content instruction and utilized a variety of instructional techniques including hands-on, inquiry-oriented methods with an emphasis on application. The content focused on chemistry in biology with topics and activities selected to strengthen the subject matter background of teachers in topics typically covered in grade 7–10 physical sciences classes. Participants were not only exposed to content, but also collaborated in interactive laboratory experiences. In addition, activities included two one-day follow-up sessions during the academic year and on-site visits from project staff. (Garimella, 2011)

> A Florida MSP project, BIOSCOPES, offered a two-week summer institute with follow-up activities to 6th–12th grade teachers in two areas of life science, ecology and diversity, and cell biology and chemistry. During summer institutes, participants worked with teams of practicing teachers, scientists, and mathematicians from the university. Participants learned fundamental science concepts through simulation and modeling activities, inquiry-based investigations, current research, data analysis, and group investigations. Follow-up activities were structured to support teachers' application of science content in schools through collaborative lesson planning and lesson study, and analysis of standards and instructional strategies and resources. This model provided participants with a school-based sustainable community of support for reflective implementation of effective curriculum and teaching. (Travis, 2011)

Exhibit 18: Types of Professional Development Models, Performance Period 2010

Professional Development Model	Percent of Projects (N=565)
Summer institute only	2%
Summer institute with follow-up activities	49
Focus on school-year activities	49

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

Projects Focusing on School-Year Activities

The remaining 49 percent of MSP projects that did not conduct a summer institute in PP10 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 professional development sessions or workshops interspersed throughout the summer months as well as during the school year. Slightly over one-fourth of projects (27 percent) reported offering between one and two weeks of professional development in the summer, while 10 percent of projects offered less than one week of professional development in the summer. Ten percent of projects held all of their professional development activities during the school year.[17] 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.

> The Teachers Addressing Mathematics Learning (TAML) project provided Arizona teachers with one week of Intel math during the summer, and four 10-hour weekends of Intel math and four 10-hour sessions of Mathematics Learning Community sessions both during the school year. Intel math focused on arithmetical operations and foundational algebra through problem solving activities related to the K–8 classroom. Teachers engaged in Mathematics Learning Communities to reinforce mathematics content learning as they analyzed student thinking and improved their own instructional practices. In addition, teachers were required to complete two observations of their peers’ mathematics classrooms, with a follow-up discussion. (Cooke, 2011)

> The Core Partners in Science (CPIS) project provided 47 middle school teachers with 45 hours of graduate content instruction through six full-day seminars, including three continuous days in the summer and three during the school year and three 2-hour afterschool workshops. The content included the integration of life, earth, and physical science through a mixed-methods approach utilizing inquiry as well as traditional techniques. The seminars targeted instructional strategies, technology applications, and rotating breakout sessions for more in-depth coverage of content and small group activities. The project required that teachers commit to 20 hours of supplemental activities integrating the learning processes from the course through year-long projects that impact teaching, learning, and the district’s STEM initiatives. In preparation, five workshops were held on the project options: lesson studies, action research, inquiry projects, content learning, and unit development. The project addressed teacher content needs, while incorporating the Massachusetts Framework for Science, Technology, and Engineering Standards. (Wicks, 2011)

Hours of Professional Development Provided

Exhibit 19 shows the median number of hours of professional development[18] 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 summer institutes with follow-up activities provided a median of 100 hours. When the time spent

[17] Numbers do not add up to total percent of projects with focus on school-year activities. This is partly due to rounding, and partly because seven projects that selected a professional development type of “Other” (school-year focus) did not answer this follow up question.

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

during the summer was analyzed separately from school-year activities, projects spent a median of 62 hours during the summer institute, and a median of 32 hours on follow-up activities.

Exhibit 19: Median Hours of Professional Development, By Model Type, Performance Period 2010

Professional Development Model	Median Number of Hours
Summer institute only	80
Summer institute with follow-up activities:	100
Summer institute portion	*62*
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: 10 percent; and focus on school-year activities: <1 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 PP10. 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 summarizes 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 PP10 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 62 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 (16 percent). Other reported activities include coursework at universities (12 percent), conferences (4 percent) and on-line course work/distance learning networks (2 percent). Finally, 4 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 2010

Primary Focus of Professional Development Activities	Percent of Projects (N=549)
On-site activities during academic year	62%
Study groups	16
On-line coursework / distance learning networks	2
University courses	12
Conferences	4
Other activities (including field experiences, mentoring, conference attendance)	4

Source: Annual Performance Report items V.B.(ii), V.B.(iii)
The non-response rate was <1 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, 62 percent of all MSP projects reported that they engaged in on-site professional development activities during the academic year. Most of these projects also held two-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.

> The Science Inquiry through Modeling Pedagogy, Content Learning, and Evaluation (SIMPLE) project in South Carolina offered an intensive two-week summer institute and follow-up activities during the academic year to increase middle school science teachers' content knowledge and use of inquiry-based practices. Participating teachers were arranged into one of three grade-level content area teams (genetics, astronomy, and energy) in which they participated in inquiry-based lessons from NSF-funded and locally developed science curricula. Standards-based science content was taught through interactive inquiry-based units that modeled effective instructional strategies. Academic year follow-up included three 5-hour workshops, an interactive NASA Endeavor SPRINTT content course on global climate change, ongoing classroom observations with in-class instructional support, and on-line professional learning communities. (Lotter, 2011)

> In North Carolina, the Partnering to Reinforce Integration of Science and Math (PRISM) project provided a two-week summer institute with follow-up activities during the school

> year including Saturday workshops, and a year-long mentoring and coaching program. During the summer institute, teachers learned chemistry content using inquiry-based instruction. Two six-hour Saturday sessions and another four two-hour sessions provided follow-up training and support in the chemistry content as well as technology tools and instructional strategies. Teachers participated in on-line discussions through Moodle. Each teacher also received a mentor who provided ongoing face-to-face support and training throughout the year. Classroom observations and self-reflections were used in monitoring and coaching support strategies. (Govan, 2011)

Study Groups

Sixteen 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. Below are examples of two projects that used study groups to promote ongoing collaboration among staff.

> CATAPULT TEAMS, an MSP project in Georgia, offered summer workshops and year-long engagement of teacher content knowledge about the integration of science and math in teaching. Teachers were involved in school-based math/science PLCs where teachers reviewed student work, analyzed student data, created common assessments, and increased their content knowledge. Facilitators engaged teachers in system-wide PLCs to align curriculum and assessments vertically while also developing and implementing project-based teaching/learning units. Five vertical teams with teachers from grades 7–10 were established: life science, physical science, algebra, geometry, and number/data analysis. (Miller, 2011)

> The Central Valley Math Project in California project provided a one-week summer math workshop and follow-up during the year through lesson study to grade 5 algebra teachers. During the workshop, teachers expanded their math content skills through hands-on exploration, problem solving, inquiry-based activities, discussion, and reflection. The lesson study enabled teachers to collaboratively design lessons that enriched student understanding by employing problem-solving and pedagogical strategies learned during the math content workshop. Teachers were placed in groups by grade level and designed and taught lessons that were examined and revised by faculty and cohort. (Brown, 2011)

Content Course Work at a College or University

With the goal of enhancing teachers' content knowledge, 12 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.[19] Below are descriptions from two projects that provided teachers the opportunity to attend university courses and earn graduate credits.

> An Illinois MSP project, Aurora Partners for Leadership in Teaching (APLET), provided teachers with the opportunity to earn an integrated Master's degree program in teacher leadership in high school and middle school mathematics. The coursework included 24 credit hours in specific mathematics content, in addition to 12 credit hours in teacher leadership courses. Some of the courses included Calculus Concepts, Theory and Application and Math Applications in Sciences, Life Sciences, and Engineering. Coursework in collecting, measuring, and analyzing real-time data stimulated inquiry; the use of statistical, GIS, and graphing software allowed participants to practice techniques and integrate them into their classrooms. Action research reinforced the necessity of applying scientifically based research methods to professional practice; while opportunities for interaction with scientists, mathematicians, and engineers from collaborating partners emphasized the real world applications of these subjects. A field experience strengthened the connections between the classroom and authentic mathematics and science in practice. (Eagle, 2011)

> The Pennsylvania State Math Science Partnership (PA-MSP) provided an 80-hour summer institute for 4^{th}–8^{th} grade science teachers and high school math teachers with follow-up during the school year. Teachers engaged in a summer institute course that focused on energy in a physics context and attended six Saturday sessions that covered themes in physics, chemistry and chemical engineering, and biology and environmental science with an applied and integrated STEM approach. Participants received three graduate credits during the summer. High school math teachers participated in a summer institute that consisted of two geometry courses. Participants received six graduate credits during the summer and participated in follow-up workshops throughout the year. Workshops focused on the relationship between sports and mathematics, how to plan culturally relevant lessons, and how to best operationalize content from arithmetic to algebra. (Hook, 2011)

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. Two 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.

[19] 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.

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. Two examples of on-line coursework and distance learning are provided below.

> The Central Oregon Consortium implemented a distance education model that provided on-line graduate level professional development access for rural teachers. The focus of the coursework was on an interdisciplinary approach to teaching mathematics, science, and technology and was framed by the four components of technological pedagogical content knowledge (TPACK). (Niess, 2011)

> The Collaborative for Teaching and Learning MSP in Kentucky deepened the content knowledge of mathematics and science teachers in grades 3–12 and at the same time, built the capacity of the district to lead and sustain improvement efforts by providing various models of professional development, including distance learning. The structure of formal training and book study sessions, as well as distance conversations, aimed to create a professional community with norms for improved practice, collegial support, and evidence gathering and reflection. (Walker, 2011)

Other Activities

Four 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.

> The Meeker Adventures in Limnology MSP engaged in a variety of limnology-related activities on the campus of Oklahoma Baptist University and in area ponds and rivers, science labs, and a water treatment plant as part of its professional development activities. Training related to limnology was conducted using a variety of instruments, including technology to analyze inland waters and the organisms within and surrounding them. All participants engaged in sampling and in data analysis of scientific findings. Follow-up activities included discussion of methods that oil and gas drillers used to ensure the safety of ecosystems, a trip to the Salt Plains Preserve to study wetlands management, a math-focused workshop led by master teachers, and a review of the PASS/Common Core guidelines as they relate to limnology studies. (Pritchard, 2011)

The Iberia Elementary MSP project in Louisiana immersed teachers in hands-on activities, scientific investigations, and field experiences, and used technology to enhance and maximize their experiences in integrating math and science. Participants engaged in activities such as scientific investigations concerned with the needs of living plants, designing imaginary organisms with specific habit needs, and comparing plant and animal cells. Teachers also engaged in world applications for environmental science and visited a graduate study site on agricultural pollution in Vermillion Parish. Participants collected data, ran tests, and prepared data charts as well as analyzing trends and predicting the probability of the data for sites downstream. Content focus areas included algebra, data analysis and probability, science inquiry, life science, and environmental science. (Olivier, 2011).

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.

As seen in Exhibit 21, more than two-thirds of projects (70 percent) reported using an external evaluator in PP10. Using external evaluators—specialized staff from outside the partnership trained to conduct evaluations—allow projects to independently evaluate their work, and to receive help from these specialists in implementing the most rigorous designs feasible. Nearly half of projects (46 percent) also reported involving their own partnership staff in their evaluations. This might have included their school system's research office or a university research department. In addition, 16 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 2010

Type of Evaluator	Percent of Projects (N= 561)
External evaluator	70%
MSP partnership organization staff	46
Statewide evaluation	16

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 PP10. Projects that used a combination of designs were instructed to report on the most rigorous design used in the project. Nearly half of projects (47 percent) reported using an experimental or quasi-experimental design. Two 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 comparison, non-participating teachers and/or students. Just over one-fourth of projects (27 percent) 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 18 percent of projects reported using a non-matched comparison group.

The remaining 53 percent of projects reported using a less rigorous design type. Thirty-eight percent of projects reported using pre-tests and post-tests to assess the gains of the teachers served by MSP. Twelve percent of projects reported using qualitative methods only, and 3 percent of projects reported using a mix of quantitative and qualitative methods.

Exhibit 22: Types of Evaluation Designs Used by Projects, Performance Period 2010

Evaluation Design	Percent of Projects (N=561)
Random assignment design (experimental)	2%
Quasi-experimental design	45
Matched comparison groups	*27*
Non-matched comparison groups	*18*
One-group design	38
Qualitative / descriptive design	12
Mixed methods	3

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

Measures Used in Evaluations

MSP projects use 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.[20] 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.

Standardized tests were the most frequently reported type of assessment utilized to assess teachers' content knowledge both in mathematics (66 percent) and in science (44 percent). The prevalence of this assessment type as a measure of teachers' content knowledge has continued to grow from 2008, when 57 percent of assessments used in mathematics and 40 percent of assessments used in science were standardized tests.

The next most frequently reported type of assessment for both mathematics (20 percent) and science (33 percent) was locally developed assessments that were not tested for validity, followed by locally developed assessments with evidence of validity and reliability (19 percent of projects for

[20] The macro uses a statistical test called a dependent t-test (for 30 or more respondents) or the Wilcoxon signed ranks test (for less than 30 *but at least 6 respondents*) to calculate, with 85 percent certainty, the number of teachers who showed significant gains on content knowledge tests.

mathematics and 22 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 2010

Assessment Type	Percent of Projects		
	Mathematics Content Knowledge (N=331)	Science Content Knowledge (N=296)	Classroom Practices and Beliefs (N=315)
Standardized test	66%	44%	39%
Local test, not valid & reliable	20	33	14
Local test, valid & reliable	19	22	11
Surveys or ratings	2	3	54
Other type of test	11	8	27

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.

Among projects that measured classroom practices and beliefs, over half of projects (54 percent) reported using surveys or ratings by teachers, students, or other MSP participants. Additionally, 39 percent of projects used a standardized test, and 25 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* (34 percent of projects), the *Reformed Teaching Observation Protocol* (*RTOP*) (14 percent), and the *Surveys of Enacted Curriculum* (15 percent).

Exhibit 24: Assessments Utilized to Assess Teachers in Classroom Practices and Beliefs, Performance Period 2010

Classroom Practices and Beliefs Assessment Measure	Percent of Projects Utilizing this Assessment (N=315)
Survey of Teacher Attitudes and Beliefs	34%
Reformed Teaching Observation Protocol (RTOP)	14
Surveys of Enacted Curriculum (SEC)	15
Teacher Efficacy Belief Instrument	12
Inside the Classroom Observation Protocol	9
Other Assessment	64

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*) (40 percent of projects) and the *Diagnostic Mathematics Assessments for Middle School Teachers* (13 percent). For measuring content knowledge in science, the two most commonly reported assessments were the *MOSART: Misconception Oriented Standards-Based Assessment* (14 percent) and the *Diagnostic Teacher Assessments in Mathematics and Science* (*DTAMS*) (11 percent).

Exhibit 25: Assessments Utilized to Assess Teachers in Mathematics, Performance Period 2010

Mathematics Assessment Instrument	Percent of Projects Utilizing this Assessment (N=332)
Learning Mathematics for Teaching (LMT)	40%
Diagnostic Mathematics Assessments for Middle School Teachers	13
State Teacher Assessment	4
Knowledge of Algebra for Teaching	2
PRAXIS II	2
Other Assessment	56

Source: Annual Performance Report item VII.D

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

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 2010

Science Assessment Instrument	Percent of Projects Utilizing this Assessment (N=298)
MOSART: Misconception Oriented Standards-Based Assessment	14%
Diagnostic Teacher Assessments in Mathematics and Science (DTAMS)	11
State Teacher Assessment	8
Assessing Teacher Learning about Science Teaching (ATLAST):	4
Force Concept Inventory	<1
PRAXIS II	1
Other Assessment	69

Source: Annual Performance Report item VII.D

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

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*, just over half of MSP projects (54 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 (47 percent) and/or other types of tests (21 percent) to assess student achievement.

Exhibit 27: Types of Assessments Utilized to Assess Student Achievement, Performance Period 2010

	Percent of Projects	
Assessment Type	Mathematics (N=273)	Science (N=220)
Standardized test	92%	54%
Local test, valid & reliable	9	33
Local test, not valid & reliable	11	14
Self-report	1	2
Other type of test	3	21

Source: Annual Performance Report item VII.D.1

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

The non-response rate was 29 percent for Mathematics and 38 percent for Science.

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, approximately four-fifths of projects (82 percent) in PP10 used questionnaires or other forms of self-reporting by teachers, and two-thirds of projects engaged in direct classroom observation (67 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. One-fourth of projects (25 percent) reported reviewing journals in which participants tracked lesson plans and reflected on classroom practice. Eighteen 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 2010

Measures	Percent of Projects (N=565)
Questionnaire/Self-report	82%
Classroom observation	67
Journals	25
Videotaping	16
Interviews/Focus groups	8
Lesson plan analysis	7
Blogs	7
Other	18

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 0 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 participating in professional development courses in mathematics and science and the proportion who had pre- and post-assessment data available in each of the past three performance periods.[21] In mathematics, 25,344 teachers reported receiving professional development courses in PP10, and 53 percent of these teachers had assessment data available for the period. In science, 19,562 teachers reported receiving professional development courses in PP10, and 60 percent of these had assessment data available for that period. Although the total number of teachers served in both math and science decreased in PP10, the proportion of teachers with assessment data increased.

[21] 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.

Exhibit 29: Number of Teachers Served and Percent of Teachers Assessed, Performance Periods 2008–2010

Content Area	Total Number of Teachers Served			Percent of Teachers with Content Assessments (Pre-Post)		
	PP08	PP09[1]	PP10	PP08	PP09	PP10
Mathematics	36,546	31,512[2]	25,344	43%	42%[2]	53%
Science	31,762	23,310	19,562	47	47	60

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

Individual teachers who received professional development in both mathematics and science may be included in the number of both science and math teachers.

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

[2] This number was adjusted from last year's report, based on additional information we obtained from one project.

Exhibit 30 presents data for those teachers who were assessed for gains in content knowledge. Among the teachers assessed in PP10, 65 percent showed significant gains in mathematics content knowledge and 74 percent showed significant gains in science content knowledge. A notable portion of these gains (66 percent in mathematics and 44 percent in science) were found using standardized tests, which are often 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 2008–2010

Content Area	PP08	PP09	PP10
Mathematics	67%	62%	65%
Science	73	71	74

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

Student Outcomes

Projects also reported the number of students served, assessed, and scoring at the proficient level or above in state assessments of both mathematics and science. As shown in Exhibit 31, over 1.25 million students in PP10 were taught by teachers who received professional development in mathematics, and nearly 1 million students were taught by teachers who received professional development in science. The number of students taught decreased by nearly 200,000 from PP09. This decrease was associated with the decrease in the number of teachers participating in professional development activities. Interestingly, the percent of students with content assessments increased, in parallel with the trend in teacher assessment. It is possible that some of this increase is a result of policy goals of the No Child Left Behind Act.

Exhibit 31: Number of Students Served and Percent of Students Assessed, Performance Periods 2008–2010

Content Area	Total number of students taught by MSP teachers			Percent of students with content assessments		
	PP08	PP09	PP10	PP08	PP09	PP10
Mathematics	1,442,254	1,476,835	1,280,438	43%	51%	64%
Science	1,252,853	1,157,168	903,788	26	33	39

Source: Annual Performance Report items VIII.B. 1, 2, 5, 6

Students who are taught by teachers receiving professional development in math and science may be double counted.

State assessment data were reported for 64 percent of students in mathematics and for 39 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 nearly two-thirds of students in math and just over 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.

The proportion of students being assessed at the proficient level or above continued has increased over the past three years. In PP10, in mathematics, 65 percent of students scored at the proficient level or above, and in science, two-thirds of students (67 percent) scored at the proficient level or above.[22] The increasing trend of students scoring at the proficient level continues a trend beginning in from PP07, when only 45 percent of students in mathematics and 49 percent in science scored at the proficient level or above. 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.

Exhibit 32: Percent of Students Taught by MSP Teachers Scoring at Proficient Level or Above, Performance Periods 2008–2010

Content Area	Proficient Level or Above		
	PP08	PP09	PP10
Mathematics	58%	64%	65%
Science	58	63	67

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

In PP10 the non-response rates were 8 percent in mathematics and 7 percent in science; in PP09 the non-response rates were 8 in mathematics and 11 in science; and in PP08 the non-response rates were 17 in mathematics and 19 in science.

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

Chapter 5: Special Topics

While MSP projects share key elements, they vary in terms of their approaches to professional development, participants served, and impacts. This chapter provides insights gleaned from a qualitative assessment of the PP10 Annual Performance Reports, along with proposals submitted by MSP projects to present at annual program conferences, which together complement the findings presented in the previous chapters. The chapter begins by exploring how MSP projects are targeting various teacher populations as well as new STEM content topics, particularly engineering. It also examines how some MSP projects are overcoming challenges with data collection and identifying appropriate assessments. Then, it offers examples of the provisions MSP projects make for sustainability, through training future leaders and partnering with business and industry. Finally, it describes how MSP projects contribute to larger statewide initiatives and help prepare for the adoption of new STEM content standards.

Targeting Various Teacher Populations

Although the MSP program's governing statute does not stipulate the types of teachers that may participate in MSP professional development, the majority of teacher participants are either general classroom teachers who teach all subjects, including math and science, or middle or high school teachers of STEM subjects. Some MSP projects integrate other types of teachers who may also benefit from STEM professional development.

> In Wisconsin, the Alliance for Teaching Mathematics to Special Education Learners' goal was to strengthen both general and special education teachers' ability to teach math to special education students with appropriate accommodations and modifications. Each year, participants enroll in a math content course, taught in conjunction with a seminar on math education and differentiation. The seminars are co-planned and mutually reinforcing. A teacher said, "I now possess higher standards for my students with disabilities...as a result of seeing their ability to demonstrate mastering math on a deeper level." (Huinker, 2011)

> Northern Illinois University's Integrated Technology and Engineering to Advance Mathematics and Science (ITEAMS) project sought to address critical workforce issues, and to ensure that career and technical education is as rigorous as college preparatory programs, by including career and technical education teachers alongside general education teachers in their program. It created a master's degree program that integrates STEM standards into the middle and high school industrial technology endorsements. Local businesses provided internships in critical technologies such as nanotechnology, fuel cells, and manufacturing. (Tahernezhadi, 2011)

Some MSP projects also included preservice teachers in their participant group, or collaborated in some way with a preservice program, to provide future teachers with a level of rigorous STEM preparation that they might not otherwise have received. Below are two examples of projects where MSP work with inservice teachers impacted the IHE preservice program and its students.

> In the Teaching for Excellence in Science and Literacy Achievement (TESLA) project, IHE faculty in Idaho made significant changes to their elementary science methods course to include the MSP model of instruction and the use of science notebooking. As a result, preservice teachers in that district are more easily able to transition to classroom teaching,

> and preservice teachers and IHE faculty now work directly with K–12 students at science events such as an outdoor orienteering camp. (Wareham, 2012)
>
> The “World is Flat” project, a collaboration between the Springfield School District and Springfield College in Massachusetts, 24 preservice teachers collaborated with 74 classroom teachers in workshops, field trips, co-designing courses, and an action research cycle on identifying and changing student misconceptions. Changes were made both to the district’s middle school curriculum and the IHE partner’s preservice courses to include misconceptions-based teaching. When the preservice teachers begin student teaching, they will be placed in classrooms with inservice co-participants. (Barkman, 2011)

Projects recognize that rigorous preparation in STEM content can benefit a wider range of students than those found in general education classrooms. To that end, some MSP projects extend professional development to other teacher types, such as teachers of special education students, English language learners, or career/technical education. By including preservice teachers in their partnership model, some projects ensure more vertical alignment between the university and the local school districts, and help promote the sustainability of MSP’s impacts.

Integrating Engineering into K–12 Classrooms

MSPs not only introduce more rigorous STEM content to a broad range of teacher types, but they also expand the range of STEM content topics typically covered in professional development. A noteworthy example of a content topic included in some MSP projects is engineering, whose study is often been relegated to the post-secondary level. However, some critical skills for engineering, such as problem-solving techniques, may enhance STEM learning in other disciplines more commonly found in a K–12 curriculum. To increase alignment between K–12 schools and workforce/post-secondary institutions, some MSP projects focused on engineering.

> In North Dakota, Bringing STEM Education and Engineering Concepts into the Classroom partnered with engineering schools and practicing engineers to provide professional development to K–12 teachers, with the goal of engaging students to choose an engineering career path. Participants took part in LEGO® robotics and roller-coaster/engineering design activities. Then, during a two-week summer institute, teachers received content instruction from practicing engineers in the morning, then worked with STEM instructors to translate those concepts to the classroom. (Bagstad, 2011)
>
> The Rural Math and Science Leadership Initiative 3 program offered rural Illinois teachers a summer institute featuring a design-based robotics challenge. Participants then formed lesson study groups to design and implement engineering lessons during school-year follow-up. Teachers took field trips and held discussions with community partners such as the Boeing Corporation and the Army Corps of Engineers to learn about real-world contexts of engineering. (Marlette, 2011)

In some states, the integration of engineering skills and topics occurs at a higher level than in individual projects, especially as engineering is increasingly incorporated into statewide and national STEM standards and curricula. MSP projects that focus on engineering and technology can improve student and teacher understanding of the nature of science, scientific practice, problem-solving, and the issues faced by real-world scientists.

Facilitating Data Collection and Assessment

As MSP projects develop and improve over time, some pay increased attention to the quality of data collection and conducting strong monitoring and evaluation of their work. Some MSP projects developed tools and resources to introduce more rigor into their approach for collecting and evaluating data. For example, the Texas Regional Collaboratives developed an innovative online data collection and aggregation tool, the TRC DataCenter, to keep track of many individual MSP partnerships and teachers:

> When the MSP program began, it became clear that each Regional Collaborative needed control of their data to ensure better data integrity. A system was developed that allowed each TRC to input teacher, school, and district data directly into the database through an online portal, while demographic school and district data was imported from the Texas Education Agency (TEA). An "Events" feature tracks the specific professional development offered to individual teachers. The DataCenter also collects the specific types and format of information needed to complete the APR so projects only enter this once. This online tool allows the TEA directly access all individual projects and data, to monitor in real time. Data may be easily aggregated across projects, and each project has an effective tool for tracking its own services and communicating with stakeholders. With today's rapid application development tools such as FileMaker, online data collection tools can be created with a reasonable investment of resources for grant-funded projects. (Fletcher, 2012)

Along with the difficulties of tracking data for multiple teachers, another challenge reported by many MSP projects is the inability to find an appropriate assessment that is rigorous and valid, but also tailored to the content of their professional development. In Puerto Rico, the Alianza de Matemáticas y Ciencias del Turabo (AMCT), discussed below, addressed this challenge by validating its own local assessment:

> Key aspects of their validity process were:
>
> - Development of an academic plan and syllabi design for the academic year;
> - Faculty involvement by producing individual test items focused on the workshops that they will deliver;
> - Selection of items and test development;
> - Test revision by a panel of experts, including examining the alignment with state and project requirements, content, and form;
> - Pilot testing and interviews with pilot test teachers; and
> - Integration of the final test.
>
> Key aspects of the reliability testing included:
>
> - Item revision for complexity/time consistency;
> - Definition of grading process;
> - Definition of data collection and data entry activities;
> - Spreadsheet configuration and exporting to statistical software; and
> - Reliability measurement using Cronbach's Alpha.
>
> The project had more control over the validity process than the reliability process. Due to small sample size, it was hard to get sufficient power for the reliability process. (Saenz, 2012)

Training Teacher Leaders

One way that MSP projects seek to expand their impact and sustainability is to incorporate training for teacher leaders into their professional development. Trained teacher leaders can return to their home school or district and share what they have learned with other teachers who did not participate in MSP. As such, they may continue to mentor others beyond the lifespan of the MSP grant.

Some MSPs use a peer coaching or mentoring model to deliver the professional development to participants. As teacher participants receive the professional development and become more knowledgeable, they too can transition to a leadership role.

> The Novice-to-Expert Through Inquiry-Based Teaching and Learning project trains Indiana teachers to share the results of the professional development with their home schools. Professional development was led by classroom teachers, referred to as Master Science Teachers. All teacher participants were considered Science Liaisons, and moved through a hierarchy of Novice, Experienced, and Expert levels of professional development, each with its own curriculum. They also created a strategic plan with the superintendent, curriculum personnel, school board members, and principals to ensure continued support of inquiry science. (Benak, 2011)

Some MSP projects consider the training of instructional leaders to be their primary goal:

> The Strategic and Intensive Mathematics Initiative Phase 2 (SIMI-2) project in California designed a Math Coaching Consortium to support full-time math coaches, who provide support to other teachers. Coaches receive training to improve their own coaching skills, as part of the project's explicit goal to create better mathematics leadership. Partner districts have begun to contribute funding for their non-MSP coaches to attend the same training, ensuring further sustainability of program work. (Gonsalves, 2011)

> One Connecticut project, the Danbury Elementary STEM Instructional Coaching Academy (DESICA), created an Elementary Science Instructional Coaching Academy. Future science coaches participated in monthly seminars, graduate STEM education courses, summer institutes on coaching and assessment, action research, and a supervised coaching practicum. IHE courses were developed and/or revised to meet the needs of the partnership, and the work has also led to a new master's degree program at the partner IHE, to certify elementary school teachers as Math/Science Instructional Specialists. (Rosvally, 2012)

To further ensure that MSP professional development becomes embedded in schools and districts, many projects reach out to key administrators and other LEA personnel. For example, one grant in Minnesota trained teachers in school-level teams, and in order for a school to send a team to the professional development, the building principal, district math specialist, and/or curriculum directors had to commit to attend three school-year leadership forums (Stevenson, 2012). By leveraging partnerships in the LEA to invest in MSP, and by training instructional leaders, MSP projects may expand and sustain their impacts.

Partnering With Business and Industry

In addition to teachers, administrators, and IHE faculty, some MSP projects reach out to businesses and community partners. Tapping into resources that extend beyond the formal education community can be a powerful way to leverage funds and enrich professional development content. Collaborating with industry can inform teachers about STEM careers, as well as provide field trips, real-world experience, and new perspectives on the STEM content they are studying. In addition, business and industry may contribute funds and other supports beyond the scope of MSP.

One way that businesses and industries contribute to MSP projects is hosting teacher participants for field trips and/or presentations on the ways in which they use STEM in their careers.

> The Ontario-Montclair School District's California MSP project leveraged several external partners to ensure that every content course had an experiential hands-on component through field study. For example, teachers visited an Aquarium of the Pacific research vessel for a research mission. Other teachers worked with the Water Education Water Awareness Committee and took field trips to water treatment and facilities locations; a local fire department also presented on how they use the concepts of density and buoyancy to extinguish chemical fires. (Shell, 2011)

Businesses, industries, and other external partners can also provide materials and expertise that may not be present in the district or IHE community.

> Project STAT in Oklahoma partnered with an air and space museum which presented on the mathematical aspects of flight, and a representative of NASA's Aerospace Education Services Project provided aerospace activities. Project STAT also leveraged partnerships with the Aurora Learning Community Association and Wizard Workshops to gain technology for data-driven decision-making, and to integrate technology into math instruction. (Lay, 2011)

> A Pennsylvania project, PA3MSP, drew on pre-existing grants from NASA and the National Science Foundation (NSF), allowing them to use Star Labs and a GeoDome Planetarium provided by NASA, as well as take field trips to the Goddard Space Flight Center, receive professional development from NASA and NSF scientists and engineers, and have follow-up presentations with NASA and NSF guest speakers. (Morgan & Vassallo, 2011)

Lastly, one way in which MSP projects rely on businesses and industry to enrich their professional development is through internships and externships for participants. There are many ways in which MSP teacher participants receive real-world industry experience.

> The AIMS project in South Carolina offered teachers from rural, high-poverty districts 15-day professional externships in local business and industry. Teachers also take four graduate courses and receive guidance on technology integration from a trained technological coach, helped by their partnerships with two museums and an external STEM center. (Allan, 2012)

> The TalentSparks3 partnership in Illinois used global obesity as a lens through which to train teachers in problem-based learning. They engaged over 30 experts from industry, academia, and community organizations to present on such topics as epigenetics, public policy, nutrition, drug development, hormones and feedback cycles, biotech crops, and macromolecules. Teachers worked in biotech labs, visited industry sites, and designed solutions to a real-world, complex problem, which they presented to panels of industry experts. (Reed, 2011)

A number of benefits can be gained when MSP partnerships involve business and industry. Teachers can network with experienced professionals, leading to a more nuanced understanding of career paths for their students as well as a different perspective on STEM content. Teachers may also obtain access to resources and a new professional community. Lastly, businesses offer hands-on experiences and address real-world issues that provide relevance to the content topics learned in the classroom.

Statewide Initiatives

Many states have a STEM education agenda at the state level, and several other states draw upon the resources of their MSP partnerships to define the direction of their STEM education program.

> In 2009, Minnesota rewrote its state science standards, incorporating engineering. Minnesota then leveraged its MSP projects to create a statewide structure of regional math and science teacher centers to deliver professional development that would help all teachers implement these new standards. Teachers worked in school-based teams, formed professional learning communities, and took classes specifically in engineering and technology. (Stevenson, 2012)
>
> Michigan revised its standards and the Michigan Merit curriculum in 2009. It then launched a statewide professional development program, Algebra for All (AFA), and leveraged its MSP projects to support it. By relying on a pre-existing Math and Science Center Network with 33 regional centers, Michigan could train a State-Wide Algebra Trainers team of facilitators and provide math professional development to all Michigan teachers. The project also established an online version of the course. In this way, MSP helped Michigan translate its new standards and curriculum to math teachers across the state. (Pizzo, E., 2011; Pizzo, L., 2011)
>
> Texas also used MSP funds to further a statewide professional development initiative through a network of regional math and science centers. Its MSP Professional Development Network is managed through the University of Texas, and consists of 64 regional collaboratives across the state to provide professional development in math and/or science. The collaboratives also train mentor teachers who can then provide further professional development to other teachers. (C. Fletcher, 2011; S. Avery, personal communication, October 12, 2012).

Implementing New National Standards and Frameworks

One national-scale change to K–12 education is the upcoming implementation of the Common Core State Standards in math and English language arts, as well as the current development of the Next Generation Science Standards. As many states adopt new standards, districts, schools, and teachers will need to make transformative changes to their curricula and assessment plans. MSP projects can serve as valuable resources to help implement these new standards. Below are three examples of ways in which MSP projects support teacher participants in preparing to implement the Common Core.

> In Ohio, the Warren G. Harding/Kent State University Partnership walked teachers through the CCSS model curriculum to identify the standards that were most difficult to understand and teach, such as modeling, statistics, and discrete math, and focused the professional development on those. Then, teachers examined their own courses of study to eliminate extraneous topics of review. (Caniglia, 2012)
>
> The South Arkansas Mathematics Standards Partnership created two learning progressions to help teachers align with the Common Core. They focused on embedding CCSS in learning

> structures through team teaching, observation, discussion, modeling, and other hands-on learning. (Guevara, 2012)
>
> Massachusetts' Intensive Immersion Institutes (I^3) project adapted its professional development to address the CCSS with new courses, including Exploring Common Core Math in Grades 3–8, Middle School, and Grades 7–12. Courses are designed and taught by IHE faculty based on pre-test results and common difficulties and misconceptions. The faculty member who directs I^3 is on the Common Core Development team and serves on the Advisory Board of the National Council on Teacher Quality, which has helped him design relevant courses. (Chen, 2011)

MSP resources, best practices, and networks may prove helpful for preparing educators to cope with changing demands of instruction and assessment as more states begin to implement these transformative new standards.

Conclusion

While almost all MSP projects provide content-based professional development for STEM teachers, each grant designs a unique program that leverages 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 and professional learning community format, there is great variety in their focus, structure, and approach. Moreover, many projects present useful lessons on how to leverage resources and partnerships, and how to expand the impacts of their professional development programs.

Chapter 6: Highlights from MSP Projects with Rigorous Designs

Among the 566 MSP projects funded in PP10, 15 final-year projects used rigorous evaluation designs to demonstrate the impact of their programs on teachers and students. In this chapter, we provide highlights from these 15 projects, which were hosted in six states and Puerto Rico. The review process for narrowing down the set of projects according to the criteria of rigorous evaluation design is presented in Appendix A. Appendix B describes the criteria used to determine rigor of design. By reviewing the interventions and findings of these rigorous evaluations, we can potentially learn what aspects of professional development are associated with improvements in teacher content knowledge, teacher pedagogical content knowledge, student achievement, and/or teacher practices.

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 practices, or student achievement in a rigorous manner are included in this chapter.[23]

For each project with an evaluation that passed the criteria for rigorous design, 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 2010 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, ten focused on math exclusively, and three focused on science exclusively.
- Thirteen projects aimed to increase teacher content knowledge—five focused on increasing knowledge and use of standards based instruction; four sought to improve teacher instruction or pedagogical competencies; three included a focus on technology; and one focused on use of assessment data, textbook use and reading strategies, English Language Learner instruction, and inquiry-based instruction.

Grade Levels Taught by Targeted Teachers

- One project was designed for elementary, middle, and high school teachers; six served elementary and middle school teachers; and one worked with middle and high school teachers. Four projects targeted exclusively elementary school teachers; two only worked with middle school teachers; and one was only designed for high school teachers.
- Two projects also worked with principals and school administrators.

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

Professional Development Models and Activities

- The majority of projects (14) provided summer institutes (at least 60 hours or two weeks) or summer workshops (fewer than 60 hours), and 13 of these had additional school-year follow-up activities. One focused on professional development during the school year and one included online workshop follow-up.
- Three projects included Lesson Study in their professional development, and five complemented their school-year trainings with professional learning communities.
- Seven projects involved university faculty, including psychology, math, and math and education professors, in the administration of the professional development.
- One project offered the opportunity to enroll in graduate courses and one established a new master's degree program. Another project offered participants the opportunity to attend conferences.
- Four projects provided participants with supplies such as websites with teaching material, computer software, and books.
- Three projects offered coaching or mentoring to participants and seven provided leadership training or reported that their teachers go on to become teacher leaders.

Types of Research Designs Used

- Twelve projects successfully employed quasi-experimental designs that included comparison groups, and three projects successfully implemented an experimental design.
- Eight of the evaluations found positive impacts of MSP on teacher content knowledge, two found positive impacts of MSP on student achievement, and four projects found positive impacts on teacher classroom practices.
- Six 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 obtain statistical significance.

Patterns from Projects with Positive Findings

- Among the eight projects with positive findings in *teacher content knowledge*, five assessed teachers using the Learning Mathematics for Teaching (LMT) assessment, two assessed teachers using Diagnostic Teacher Assessments in Mathematics and Science (DTAMS), and one project developed their own assessment and tested it for reliability.
- Among the eight projects with positive findings in *classroom practices*, three projects assessed classroom practices using the Reformed Teaching Observation Protocol (RTOP), and one project used the Abbreviated Survey of Enacted Curriculum (SEC).
- All three projects with positive findings in *student achievement* used either the state assessment or another standardized test.
- Seven out of nine projects with positive findings focused exclusively on math content.

Exhibit 33. Selected MSP Projects

MSP Project	State	Participants	Content Area	Professional Development	Design of Passing Evaluation(s)	Evaluations with Positive Findings
Connecting the Dots: Content, Research, and Practice in the Primary Grades	AR	23 K–2nd grade teachers	Math	Summer workshop plus nine monthly sessions during the school year with online reflection sessions.	QED	Teacher content knowledge; Student achievement
Chandler Intel Mathematics Academy (CIMA)	AZ	61 elementary and middle school teachers	Math	Intensive summer workshop plus workshops during fall, winter, and spring breaks, all supplemented with learning community meetings.	QED	Teacher content knowledge; Classroom practices; Student achievement
Northern Arizona Intel Mathematics (NAZIM)	AZ	69 K–8 teachers	Math	40-hour summer workshop followed by 42 hours of face-to-face and 16 hours of online instruction during the school year. Learning community meetings.	QED	Teacher content knowledge; Classroom practices
Gila Elementary Math Masters (GEMMs)	AZ	24 elementary school teachers, 8 middle school teachers	Math	6-day summer workshop and four follow-up weekend sessions during the school year, plus learning community meetings.	QED	Teacher content knowledge; Classroom practices
Excellence in Science Instruction (eSCI)	CA	110 3rd-5th grade teachers	Science	Intensive retreat, 1-week summer workshop, and 24 hours of lesson study.	RCT	Teacher content knowledge
Shasta County Math Partnership (SCMP)	CA	64 elementary and middle teachers	Math	30-hour summer workshop, 5 all-day follow-up sessions during the school year, and 2 days of lesson study.	QED	None
Project ALPHA	CA	48 middle school teachers	Math	80-hour summer institute, followed by 24 hours of follow up coaching.	QED	Teacher content knowledge
Central Valley Math Project	CA	17 elementary and 15 middle school teachers	Math	40-hour summer workshop followed by 32 hours of follow-up including lesson study activities.	QED	None
San Francisco PRIME	CA	30 4th and 5th grade teachers	Math	40-hour summer workshop, 3 days of follow-up during the school year, 12 hours of coaching, site meetings.	QED	None
Green STEM	IL	17 high school teachers	Math and Science	2-week summer institute plus 45 hours of lesson study, and 40 hours of instructional strategies.	QED	Classroom practices

MSP Project	State	Participants	Content Area	Professional Development	Design of Passing Evaluation(s)	Evaluations with Positive Findings
Alianza para el Fortalecimiento de las Matematicas y las Ciencias (AFAMaC)	PR	40 elementary school teachers, 36 middle school teachers	Science	80-hour summer institute, two weekend retreats, and eight Saturday workshops. Science books and CDs provided to teachers.	QED	None
East Tennessee Math and Science Partnership (ETnMSP)	TN	68 8th–10th grade teachers, principals of teachers	Math and Science	2 after-school workshops and a summer institute.	QED	None
Understanding Mathematics for 3rd – 5th Grade Teachers (UMATH)	TN	73 3rd–5th grade teachers	Math	Spring orientation, two summer institutes, and five follow-up days.	QED	Teacher content knowledge
SEE-Math for Middle School Teachers	TN	50 middle school teachers	Math	2-week summer workshop plus follow-up activities during the year. Materials provided to participants.	RCT	Teacher content knowledge
Rice Regional Collaborative for Excellence in Science Teaching	TX	168 3rd–5th grade teachers, 70 secondary school teachers	Science	Weekly training during the school year (either during or after school), visits to university research labs, access to online materials and mentoring.	RCT	None
Sources: Performance Period 2010 APRs and Evaluation Reports						

Connecting the Dots: Content, Research, and Practice in the Primary Grades

State (APR) ID: Arkansas (AR080615)
Partners: Jonesboro Public Schools, Blessed Sacrament School, Arkansas State University, Williams Baptist College, and an external evaluator from Arkansas State University
Project Director: Dr. Jane Jamison
Number of Participants: 23 teachers in grades K–2; 21 public and 2 private

Background:
Connect the Dots is a three-year partnership targeting students' math achievement in primary grades through teacher professional development. The project's goals include: 1) increasing K–2 teachers' mathematics content knowledge, 2) increasing their confidence in, and use of, standards-based instructional strategies, and 3) improving students' performance in math problem solving.

Description of Professional Development:
The project held a one-week intensive summer workshop that included math content sessions and algebra curriculum alignment work. During each school year, participants reconvened for nine monthly sessions, each followed by a group blog/reflection session. Each session began with an exploration of math anxiety and emotional intelligence led by a psychology professor, and then continued with algebraic hands-on activities, research, and problem-solving. All participants received at least two classroom visits and feedback from a mathematics professor. Additionally, participants continue to participate in a professional learning community.

Description of Evaluations with Rigorous Designs:
Evaluations of both *teacher content knowledge* and *student achievement* 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
Evaluators used a non-matched comparison group design to assess whether 20 grade K–2 grade teachers participating in Dots showed greater algebra knowledge than 19 comparison teachers, who did not participate in Dots, from the same schools and grade levels. Algebra knowledge was assessed via the algebra scale of the Learning Mathematics for Teaching (LMT) assessment. The evaluators reported that while both the participant and comparison groups showed an increase in LMT scores at post-test in the third year of the program, the gain was marginally significant for the participant group and non-significant for the comparison group.

Student Achievement
Students of participating and comparison teachers were compared on state achievement tests in each of the three years of the program. The tests administered to students by the state varied by year and grade. Students in the evaluation took the ITBS, MAT8 or SAT10. To account for the differences between these assessments, the National Normal Curve Equivalencies (NCEs) for the mathematics subtests were used in all analyses. Researchers compared treatment and controls groups on post-test scores, collapsing across all grade levels, at the end of each year. In year 1 the students of participants showed marginally significant higher scores than non-participants. In years 2 and 3, there was no significant difference between the students of participants and non-participants.

Despite the disparate student achievement results, evaluators report that in all three years kindergarten students of participating teachers scored higher than students of non-participants, with this comparison being significant in years 1 and 2. They interpret this finding to mean that the most measurable gains can be seen in the youngest grade levels. The researchers are hopeful that long-term benefits may be seen in future years with teachers' increased familiarity and confidence that comes with applying the skills and knowledge they have acquired from Dots.

Chandler Intel Mathematics Academy (CIMA)

State (APR) ID: Arizona (AZ100402)
Partners: Chandler Unified School District (CUSD), Chandler Gilbert Community College, and Arizona State University (ASU)
Project Director: Melinda Romero
Number of Participants: 61 elementary and middle school teachers

Background:
The CIMA project was a 14-month program that aimed to increase the number of teachers who were adequately prepared to teach mathematics, by providing professional development in key areas of math content as well as in algebraic habits of mind. The project's second goal was to increase the mathematics achievement of students in the target schools, through increasing teachers' use of multiple representations and process integration during instruction, and increasing the analysis of student work to drive and differentiate instruction.

Description of Professional Development:
CIMA's 140 total hours of professional development began with a one-week intensive summer workshop during which teachers explored addition, subtraction, and multiplication in depth. During the school year teachers participated in workshops during fall, winter, and spring breaks, which were delivered by a math educator and a mathematician. Teachers also participated in Math Learning Community (MLC) meetings throughout the semester. These were led by trained facilitators and allowed participants to examine student work, reflect on practice, and share classroom lessons.

Description of Evaluations with Rigorous Designs:
Evaluations of *teacher content knowledge* among elementary school teachers, *classroom practices,* and *student achievement* among 6th graders all 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
The evaluators assessed whether increases in mathematical content knowledge were greater among 38 teachers who participated in the CIMA project than 34 comparison teachers with similar demographics and attitudes who did not participate in CIMA. Mathematical content knowledge was assessed with the Learning Mathematics for Teaching (LMT) assessment. The evaluators reported that the post-test scores among treatment teachers were significantly higher than the post-test scores among comparison teachers after adjusting for pre-test scores.

Classroom Practices
The evaluators assessed whether flexible thinking improved among 61 teachers who participated in CIMA as compared with 58 comparison teachers with similar demographics and attitudes who did not participate in CIMA. Flexible thinking was measured using a sub-scale of the Reformed Teaching Observation Protocol (RTOP). The evaluators reported that the post-test score among treatment teachers was significantly higher than the post-test score among comparison teachers after adjusting for pre-test scores.

Student Achievement
The evaluators assessed whether mathematics achievement increased among 158 students with teachers who participated in CIMA as compared with 187 students with teachers who did not participate in CIMA. Mathematics achievement was measured using the Arizona Instrument to Measure Standards Dual Purpose Assessment (AIMS DPA). The evaluators reported that mathematics achievement increased in the treatment group while it decreased in the comparison group. Post-test scores among children who had treatment teachers were higher than post-test scores among children with comparison teachers even after adjusting for the difference in pre-test scores.

Northern Arizona Intel Mathematics (NAZIM)

State (APR) ID: Arizona (AZ100403)
Partners: Coconino County Educational Services Agency, Northern Arizona University, and 14 Arizona school districts
Project Director: Cheryl Mango-Paget
Number of Participants: 69 K–8 teachers

Background:
The NAZIM project uses Intel Math as the content curriculum for teacher professional development. The project has five goals: 1) increase mathematical content knowledge of K–8 teachers; 2) improve teacher conceptual understanding of the Arizona Academic Standard in Mathematics and knowledge of standards-based instructional applications; 3) improve mathematics instructional practice; 4) improve student conceptual knowledge and student achievement in mathematics content; and 5) promote sustainability of the project through site-based learning communities.

Description of Professional Development:
Teachers applied in district-level teams to take part in NAZIM. Participants received 40 hours of instruction in the summer, plus 42 hours of face-to-face instruction (four Friday to Saturday sessions) and 16 hours of online instruction during the school year. Between each face-to-face session, participants met in Mathematics Learning Communities (MLCs) to complete additional portions of the curriculum, such as curriculum topic study, formative content probes, and Common Core Standards alignment. During MLC meetings, teachers shared their lessons learned and developed common assessments and curriculum guides. Teachers who participated in NAZIM also participated in district-level curriculum teams and took roles as instructional leaders.

Description of Evaluations with Rigorous Designs:
Evaluations of both *teacher content knowledge* among middle school teachers and *classroom practices* 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
As part of the project's first goal, the evaluators assessed whether increases in mathematical content knowledge were greater among 27 middle school teachers (grades 6-8) who participated in the Intel Math (IM) program than among 10 comparison teachers with similar demographics and academic backgrounds who did not participate in the IM program. Mathematical content knowledge was assessed with the Learning Mathematics for Teaching (LMT) assessment. The evaluators reported that mathematical knowledge increased over time among treatment teachers, and that post-test scores were significantly higher for treatment teachers as compared with comparison teachers after controlling for pre-test scores.

> *The INTEL math course has really improved my overall understanding of mathematics in general. As my content knowledge increases, I feel my effectiveness as a math teacher also increases.*
>
> *I have never been so impacted by any class since obtaining my teaching degree. With the Intel training, I have a deeper understanding of concepts I believed I knew inside and out.*
>
> *—NAMZIM participants*

Classroom Practices
As part of the third goal of the project, the evaluators assessed whether mathematical instructional practice improved among 66 K–8 teachers who participated in the Intel Math (IM) program as compared with 45 K–8 comparison teachers with similar demographics and academic backgrounds who did not participate in the IM program. Mathematical instructional practice was measured using the Reformed Teaching Observation Protocol (RTOP). The evaluators found that overall RTOP scores for treatment teachers improved over time while RTOP scores for the comparison teachers did not.

Gila Elementary Math Masters (GEMMs)

State (APR) ID: Arizona (AZ100404)
Partners: Nine school districts and Central Arizona College
Project Director: Linda O'Dell
Number of Participants: 24 elementary and 8 middle school teachers

Background:
The Gila Elementary Math Masters program seeks to implement the Intel Math curriculum to K–8 teachers in Gila County to increase mathematical content knowledge of teachers and academic achievement of students taught by these teachers. In addition to the content courses, GEMMs trains a leadership cadre to form and facilitate Mathematics Learning Communities (MLCs) to help monitor teacher progress.

Description of Professional Development:
A math content instructor and a math educator presented the Intel Math program during a six-day summer workshop and four follow-up weekend sessions during the school year. Instruction focused on number theory and operations, rational numbers and linear relationships, and functions. In addition, ten participants were trained as a Leadership Cadre to facilitate MLCs at their local sites. This leadership cadre guided participants in reflecting on their experiences in the context of classroom instruction and student learning and thinking. During MLC meetings, participants examined student work, shared strategies for use with students, and engaged in mental math problems to reinforce content knowledge as well as pedagogy and instructional practice.

Description of Evaluations with Rigorous Designs:
Evaluations of *teacher content knowledge* among elementary school teachers and *classroom practices* 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
The evaluators assessed whether mathematical content knowledge increased among 24 elementary school teachers who participated in the GEMMS program as compared with 27 comparison teachers with similar demographics and academic backgrounds who did not participate in the program. Mathematics knowledge among these teachers was measured with the Learning Mathematics for Teaching (LMT) assessment. Post-test scores were higher for treatment teachers as compared with the comparison teachers, and the difference was marginally significant after controlling for pre-test scores. The evaluators conclude that elementary teachers in the GEMMS program significantly increased their content knowledge.

> *Members of our team are making comments about beginning to view math as more high level thinking: not just some rote facts. One even commented about how they could see that some people could really see math as fun and enjoy passing time.*
>
> *I look at math differently. I am not just focusing on the outcome but considering the processing going on within the student..*
>
> *—GEMMs participants*

Classroom Practices
In assessing the impact of the GEMMS program on classroom practices, the evaluators compared 31 treatment teachers with 39 comparison teachers using the Reformed Teaching Observation Protocol (RTOP). The sample includes both elementary and middle school teachers, and the RTOP assessment was the same for both groups. Post-test scores in lesson design, procedural content and communicative interactions were higher for treatment teachers as compared with the comparison teachers, and the differences were significant after controlling for pre-test scores. The evaluators conclude that classroom practices significantly improved among GEMMS program teachers.

Excellence in Science Instruction (eSCI)

State (APR) ID: California (CA100704)
Partners: Elk Grove Unified School District, five private schools, and the Sacramento Area Science Project from UC Davis and Sacramento State University
Project Director: Tammy Null
Number of Participants: 110 teachers in grades 3–5

Background:
The eSCI program provides professional development designed to improve science instruction in grades 3 through 5, and support science curricula aligned with the California Content Standards, California Subject Tests, and State Board of Education-adopted instructional materials. The professional development targets life science, as well as techniques for inquiry-based instruction, ELL instruction, and effective textbook use.

Description of Professional Development:

Participants took part in an intensive retreat focused on creating a classroom environment to foster scientific exploration and conceptual learning. They also attended a one-week summer workshop embedding science content with learner-centered pedagogy, followed by a winter institute designed to revisit and reinforce content from the summer while extending teacher learning. Meanwhile, teachers participated in 24 hours of facilitated, structured lesson study throughout the school year, which allowed site-based teacher teams to reflect on their practice, collaborate, develop new science lessons, and apply formative student assessment and standardized test data in the classroom. eSCI also maintained a website on which teachers could access forms, calendars, and lessons, as well as interact with fellow participants. Some teacher participants presented their work at a lesson study showcase and have developed as teacher leaders, as demonstrated by becoming peer coaches, winning grant funding for additional science education work, and presenting workshops for their colleagues.

Description of Evaluation with Rigorous Design:
This study followed an experimental design where groups of teachers, representing each grade and track from a school, were randomly assigned to participate in the eSCI program or not to participate in eSCI. Evaluations of *teacher* content *knowledge* and *student achievement* 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
The evaluators assessed whether increases in pedagogical content knowledge were greater among 85 teachers who participated in the eSCI program than 48 comparison teachers who did not participate in the program. Pedagogical content knowledge was tested using a measure developed by the evaluators. The measure was graded according to a five-category rubric, and had a reliability of over 0.9. Teachers in the eSCI program scored moderately higher than teachers in the comparison group after controlling for pre-test content knowledge, and the effect size was found to be statistically significant. They concluded that teachers in the program learned more about science and pedagogy.

Student Achievement
The evaluators assessed whether physical science knowledge increased among 1,937 students with a teacher who participated in eSCI as compared with 1,186 students with a teacher who did not participate in the program. Physical science knowledge was measured using an assessment developed by the evaluator that was aligned with California's science standards and that had high reliability. Students in classrooms taught by eSCI teachers performed slightly better than students in comparison classrooms in the first year, but the difference barely reached statistical significance. Based on the results from the three years of the evaluation, the evaluators conclude that eSCI did not impact student achievement.

Shasta County Math Partnership (SCMP)

State (APR) ID: California (CA100706)
Partners: Four school districts, the Shasta County Office of Education, and Shasta College
Project Director: Chris Dell
Number of Participants: 64 elementary and middle school teachers per year

Background:
The Shasta County Math Partnership uses a combination of content-driven professional development and lesson study work to target their three goals: 1) deepening the teachers' understanding of mathematics subject matter; 2) bolstering the use of engaging, hands-on problem solving strategies in the classroom; and 3) advancing the use of assessment data to drive decision-making for lesson plan design and delivery.

Description of Professional Development:
Teachers attended a 30-hour summer workshop of intensive geometric reasoning content. During the following school year, SCMP provided two all-day sessions devoted to lesson study in grade-level collaborative teams. Each team planned a standards-based lesson with the guidance of the facilitator and then taught and debriefed the lessons multiple times over the next week. SCMP also offered five full follow-up days of professional development in math content. SCMP teachers began to provide lesson study training to the district when it implemented lesson study district-wide.

Description of Evaluation with Rigorous Design:
The evaluation of *teacher content knowledge* among elementary school teachers passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of this evaluation are described below.

> *I feel less isolated. I'm more apt to ask for help.*
>
> *The TLC has made me think more about the student thinking process while planning.*
>
> *They expect this kind of learning now and make comments like, "This is fun!" Many students say math is their favorite subject.*
>
> *—SCMP participants*

Teacher Content Knowledge
The evaluators used a non-matched comparison group design to assess whether geometry content knowledge increased among 43 elementary school teachers who participated in the SCMP as compared with 37 elementary teachers who did not participate in the program. Teachers' geometry content knowledge was assessed using the geometry subscale of Learning Mathematics for Teaching (LMT) assessment. Although the evaluators reported gains among treatment teachers, a comparable increase in geometry knowledge occurred among comparison teachers.

Project ALPHA

State (APR) ID: California (CA100708)
Partners: El Rancho Unified School District and CSU Fullerton
Project Director: Tor Ormseth
Number of Participants: 48 middle school teachers

Background:
The Project ALPHA professional development model focuses on broadening mathematical instruction to include several dimensions of math competence not typically covered in prior math classes: conceptual understanding, strategic competence, adaptive reasoning, and productive disposition, in addition to procedural fluency. They chose a coaching model to target the relationships between the teacher, the students, and the mathematics during classroom interactions.

Description of Professional Development:
Each year of Project ALPHA's professional development began with an 80-hour summer institute, implemented by the project's instructional coaches. During the summer institute, teachers discussed specific content topics, problem-solved in groups, designed and revised lessons, and worked on their data analysis and coaching skills.

The three summer institutes were designed to expose teachers to progressively more complex math content and help participants not only improve their skills and knowledge, but also develop into leaders and facilitators for their peers. The follow-up coaching cycles progressed over time as well, shifting from the coaches modeling lessons in year one, to team-teaching in year two, and finally, to participants delivering lessons for coach feedback in year three.

Teachers then participated in a minimum of 24 follow-up hours that included individual coaching cycles of pre-conferencing, classroom interaction, and post-conferencing. Math coaches and IHE faculty also facilitated monthly after-school sessions allowing teachers to delve further into content topics, analyze student work samples, and plan activities. Several teachers also held Math Parent nights to involve parents in balanced instruction, and others became involved in curriculum planning meetings at their school sites.

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

Teacher Content Knowledge
The evaluators used a non-matched comparison design to assess whether mathematical content knowledge increased among 41 treatment teachers as compared with 30 comparison teachers. Mathematical content knowledge was tested using the Elementary Number Concepts and Operations sub-scale of the Learning Mathematics for Teaching (LMT) assessment. The gain in test scores among treatment teachers was significant while the gain among comparison teachers was not. As a result, the researchers conclude that mathematical content knowledge improved among Project ALPHA teachers.

Central Valley Math Project

State (APR) ID: California (CA100712)
Partners: Sanger Unified School District, Kings Canyon Unified School District, San Joaquin Valley Math Project, CSU Fresno, Educational Resource Consultants
Project Director: Jeff Brown
Number of Participants: 17 elementary and 15 middle school teachers

Background:
The Central Valley Math project's goals are twofold: 1) increase teacher content knowledge in math, and 2) increase students' achievement in math. The project selected 40 teachers who had never received previous MSP training to focus on subject matter expertise and learning effective teaching practices.

Description of Professional Development:
Teacher participants received 40 hours of intensive professional development during a one-week summer math workshop, conducted by members of CSU Fresno's Math and Education departments. Each day of the workshop devotes half the day to grade-level math content and the other half to lesson study. During the 32 hours of classroom follow-up, teachers continue their lesson study work in groups facilitated by teacher leaders, who participated in project trainings and also formed their own cross-district lesson study group. Lesson study groups worked to teach, revise, and re-teach lessons collaboratively by grade level, and attended workshops on special topics such as use of technology.

Following their participation in K–12 instruction, faculty in the math department of CSU Fresno have changed their curricula, authored textbooks to support teacher education, and developed and/or redesigned the content and delivery of multiple math courses, including the methods courses for their teacher education program.

Description of Evaluation with Rigorous Design:
The evaluation of *teacher content knowledge* among elementary school teachers passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of this evaluation are described below.

Teacher Content Knowledge
The evaluators assessed whether geometry knowledge increased among 10 teachers who participated in the project as compared with 11 comparison teachers with similar demographics and academic backgrounds who did not participate in the project. Geometry knowledge was tested using the geometry sub-scale of the Learning Mathematics for Teaching (LMT) assessment. The gain in test scores among treatment teachers was greater than that experienced by comparison teachers, but not by a significant margin. As a result, the researchers concluded that geometry content knowledge did not improve among elementary school teachers participating in the project.

> *Our lessons really utilize the concept needed to be learned. We allowed time for them to explore and develop the concept. Lessons did not just require a student to learn a formula and plug in the numbers repetitively.*
>
> *All I know is that, instead of just seeing a math concept now, I anticipate which types of questions the students will have, which kinds of mistakes they will make and how I would be able to move them from the concrete materials to the abstract learning. This makes my lessons more productive because the students are better able to grasp the concepts and expand on them.*
>
> *—Program participants*

San Francisco PRIME

State (APR) ID: California (CA100714)
Partners: San Francisco Unified School District (SFUSD), San Francisco State University (SFSU), and the Bay Area Math Project at UC Berkeley.
Project Director: Lise Dworkin
Number of Participants: 30 teachers in grades 4 and 5

Background:
PRIME's mission is to improve student achievement in mathematics through professional development for teachers in grades 4 and 5. The grant particularly focuses on addressing the achievement gap by targeting schools with high proportions of African American, Hispanic/Latino, and English learner students. To this end, the professional development emphasizes not only math content, but also multiple learning modalities, designing engaging lessons, and analyzing student math misconceptions. The program also aims to develop teacher leaders who can continue to lead professional development in their sites and districts.

Description of Professional Development:
Teachers participated in a 40-hour, one-week summer intensive professional development in standards-based math content and pedagogical instruction, led by SFSU and Bay Area Math Project faculty. During the ensuing school year, teachers had three release days for follow-up professional development. They also received 12 hours of in-class coaching, during which they shared student work and reviewed lesson plans, 8 hours of collaborative site meetings, and after-school centralized workshops.

Assessments and curricular/teaching materials developed by PRIME project director, coaches, and IHE partners have been made available not only to participants, but also district-wide, via a public website which is regularly updated. Moreover, the education department at SFSU has reconsidered its approach to mathematics education and teaching materials provided to pre-service teachers in light of the work done by PRIME.

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

Teacher Content Knowledge
The evaluators assessed whether algebra content knowledge increased among 30 teachers who participated in the project as compared with 14 comparison teachers who did not participate in the project. Algebra knowledge was tested using a sub-scale of the Learning Mathematics for Teaching (LMT) assessment. The evaluators found that algebra content knowledge increased by a significant margin for both treatment and comparison teachers.

I have fallen in love with teaching math. I really enjoyed watching my students get those "aha" moments in math. I enjoyed giving them choice when it comes to strategies to solve problems. I enjoy challenging them and finding real life connections. But most of all, I loved watching them struggle and learn. As their teacher, I've learned so much about what it means to be an effective math teacher.

Prime has transformed my teaching. I take time to make models (fractions, decimals...) that build number sense with my students throughout the year. I now feel confident teaching and facilitating problem solving lessons.

—PRIME participants

Green STEM

State (APR) ID: Illinois (IL100957)
Partners: St. Clair County Regional Office of Education, Lindenwood University, and high-needs school districts
Project Director: Gloria Oggero
Number of Participants: 17 high school teachers (8 mathematics and 9 science)

Background:
Green STEM supports teachers in high needs districts throughout Illinois. The objectives of the project are: 1) to offer educators the opportunity to receive graduate credit in content areas; 2) to increase teachers' knowledge in mathematics, science, effective use and integration of technology, and content area reading strategies; 3) to build a community of scholars; and 4) to increase teachers' exposure to experts in their field of study.

Description of Professional Development:
Green STEM used the environment as a catalyst for fulfilling their professional development goals. Teachers participated in two-week summer institutes that included field experiences studying streams, caves, meadows, forests, and other habitats. During the rest of the institutes, teachers focused on additional content, scientific pedagogy, and content reading strategies. Green STEM continued during the school year with 45 hours of lesson study and action research in the fall, followed by 40 hours of instructional strategies in the winter. Participants produced DVDs addressing specific content, which have been recorded for sharing with others in the future.

Description of Evaluations with Rigorous Designs:

The evaluation of *classroom practices* among math teachers 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
Evaluators used a matched comparison group design to assess whether 8 math teachers participating in Green STEM had larger increases in collegiality and use of educational technology measures than 19 comparison teachers from similar schools with similar academic backgrounds who did not participate in Green STEM. Measures were obtained from the Abbreviated Survey of Enacted Curriculum. The evaluators reported that although gains on the collegiality measure were not significantly different between participant and comparison teachers, participants made significant gains in their use of educational technology, while the comparison teachers did not.

> *Asking me to develop lesson plans and unit plans worked really well. I thought those activities were excellent. The teacher presenters were fantastic. The amount of support and collaboration was also very good.*
>
> *The Green STEM project has enabled me to provide hands-on activities to the children that I teach. I wish to stress this to you, without Green STEM I would have received nothing in my 6+ years of teaching in (omitted) in order to teach either Physical Science or Biology to the children of the district.*
>
> *—Green STEM participants*

Alianza para el Fortalecimiento de las Matematicas y las Ciencias (AFAMaC)

State (APR) ID: Puerto Rico (PR080621)
Partners: The University of Puerto Rico at Mayagüez, and the school districts of Aguada, Hormigueros, Mayagüez, Moca, Rincón, and San Sebastián
Project Director: Jose R. Lopez
Number of Participants: 40 elementary and 36 middle school science teachers

Background:
AFAMaC targets science education of grade 4–9 students across six school districts, focusing on providing intensive content knowledge to teachers in biology or biological sciences, chemistry, physics, and geology or earth sciences. The ultimate aim of the program is to improve student achievement in science in targeted grades and school districts. By partnering with the University of Puerto Rico's Mayagüez campus, the program was able to provide professional development to teachers presented by faculty members and graduate student from the biology, chemistry, earth sciences, and physics departments.

Description of Professional Development:
AFAMaC offered 160 hours of professional development, presented by faculty and graduate students from the biology, chemistry, earth sciences, and physics departments. This encompassed an 80-hour summer intensive, and two weekend retreats. Projects also took part in eight Saturday workshops. Professional development activities were divided evenly between the four science disciplines and included workshops, laboratory activities, field trips, and lectures.

In addition to the professional development delivered live, university faculty produced 13 books and several CDs, as well as posters and test banks about science topics such as rocks and minerals, the geological history of Puerto Rico, motion and Newton's laws, and chemistry demonstrations for the classroom. These books and CDs are provided to the teacher participants as continuing resources and can also be shared with others. AFAMaC reports also that one of their elementary school participants received an Amgen Award for Science Teaching Excellence, one of only 34 awards in Canada, the U.S., and Puerto Rico.

Description of Evaluations with Rigorous Designs:
The evaluation of *student achievement* in 7th graders passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

Student Achievement
Seventy-six 7th grade students of participating teachers were compared to 66 7th grade students of comparison teachers on assessments created specifically for the evaluation. Pre- and post-tests were administered to students of participating and comparison teachers at the beginning and end of the academic year. Results indicate that students of participating and comparison teachers made significant gains between pre and post-tests.

East Tennessee Math and Science Partnership (ETnMSP)

State (APR) ID: Tennessee (TN080110)
Partners: Maryville College and schools in Blount, Fentress, and Union
Project Director: Terry L. Simpson
Number of Participants: 68 grade 8–10 math and science teachers, 2 math coaches, and principals of teacher participants

Background:
The three-year ETnMSP project builds on a prior grant, the East Tennessee Science Partnership. After the initial three years of ETnMSP work, the partnership applied for and was granted a one-year extension period to continue follow-up support to participants, evaluation of the grant, and the development of resources for statewide use.

Description of Professional Development:
ETnMSP offers an individualized professional development plan for each participating teacher and principal, alongside coaching and mentoring for effective implementation. Principals were trained on monitoring and collection of math and science classroom data. Teacher professional development was centered on data analysis strategies, tools to engage students in higher order thinking, creating action plans, and how to access research-based interventions and resources.

ETnMSP also provided support to university content faculty who delivered the professional development, including reviews of the K–12 standards-based reform movement, interpreting K–12 standardized test data, and the K–12 curriculum frameworks.

Since the PP10 year was a grant extension, the professional development activity consisted of two after-school workshops for former participants, targeting specific gaps in standards identified by the teachers. However, the primary focus of the extension year was to convene 90 participant teacher leaders for a summer "boot camp" during which they identified, vetted, and posted over 1000 resources to the state curriculum website, linking each resource to a specific content standard.

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

Teacher Content Knowledge
The evaluation followed a "switching replications" design based on two groups of teachers from schools in three counties. In the first year, one group of teachers participated in the ETnMSP and the other group, which served as the comparison group, did not. In the second year, the comparison group from the first year participated in the ETnMSP while the other group did not. The researchers assessed whether factual knowledge increased among 27 teachers who participated in EtnMSP in the first year as compared with 41 comparison teachers in the other group who did not participate in the project that year. Factual knowledge was tested using a sub-scale of the Diagnostic Teacher Assessments in Mathematics and Science (DTAMS) assessment. A slight decrease in test scores was noted among treatment teachers while a slight increase in test scores was noted among comparison teachers. The evaluators conclude that EtnMSP did not result in a significant increase in factual knowledge.

Understanding Mathematics for 3rd–5th Grade Teachers (UMATH)

State (APR) ID: Tennessee (TN090114)
Partners: Austin Peay State University, Middle Tennessee State University, and 13 school districts
Project Director: Dovie Kimmins and Mary Martin
Number of Participants: 73 teachers from grades 3-5

Background:
UMATH aims to provide teachers with a more meaningful understanding of basic mathematical concepts, drawing upon the revised state mathematics standards for grades 3-5 and concentrating on numbers and operations, algebraic reasoning, geometry, and measurement.

Description of Professional Development:
UMATH provided professional development to two cadres of teachers with residential summer institutes and integrated follow-up during the school year. Each cadre received 18 months of professional development, beginning with a spring orientation day and followed by two summer institutes and five follow-up days across the next year and a half.

Though this project trains participants at various sites, the PD is delivered by a traveling workshop team to ensure fidelity, rather than having site-specific leaders. Teachers participated in school-level teams, while their principals attended related professional development seminars designed for them and led by a master teacher plus university faculty. This same master teacher serves as an instructional coach for teachers on site. Teacher participants implement the professional development in school-site teams, supported by their principals.

Description of Evaluation with Rigorous Design:
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
The evaluators assessed whether increases in geometry and measurement knowledge were greater among 57 teachers who participated in UMATH as compared with 35 comparison teachers who did not participate in the program. Geometry and measurement knowledge was assessed using a sub-scale of the Diagnostic Teacher Assessments in Mathematics and Science (DTAMS) assessment. While treatment and comparison teacher pre-test scores were comparable, treatment teachers had significantly higher post-test scores. The evaluators conclude that these higher test scores can be attributed to the UMATH training.

Student Achievement
The evaluators assessed whether student achievement in algebra increased among 14 classrooms of teachers participating in the UMATH program as compared with 14 classrooms of comparison teachers who did not participate in the program. Student achievement in algebra was measured using a subscale of the Tennessee Comprehensive Assessment Program (TCAP) Achievement Test, which is mandated by the state for students in grades 3 through 8. The evaluators found that pre-test and post-test scores in algebra were comparable between students of treatment teachers and students of comparison teachers.

SEE-Math for Middle School Teachers

State (APR) ID: Tennessee (TN090115)
Partners: Lipscomb University, Metropolitan Nashville Public Schools (MNPS)
Project Director: Ben Hutchinson
Number of Participants: 50 middle grade teachers

Background:
SEE Math aims to increase participant content knowledge of problem solving, geometry, statistics, measurement, and mathematical vocabulary, as well as pedagogical competencies. They tailor their professional development to needs identified by the partnering schools, and based in the standards supported by the National Council of Teachers of Mathematics.

Description of Professional Development:
Lipscomb University faculty presented a two-week summer workshop based on the results of needs assessments of partner school, plus follow-up activities during the school year. Training included content topics as well as appropriate use of computer software and materials for the classroom. Participants also received material resources, including calculators, computer software, and registration fees to attend local, regional, and state mathematics conferences in the fall of 2009.

Following the popularity of the MSP work, Lipscomb University instituted a new master's degree program in education with an emphasis in mathematics, which has already accepted over 30 teachers, many from local public schools. Several MSP participants have become teacher leaders and trained others in their district based on what they learned in the institutes, and one of the Lipscomb faculty members has developed new courses and is incorporating lessons from MSP into the undergraduate mathematics courses he teaches.

Description of Evaluation with Rigorous Design:
The evaluation of *teacher content knowledge* in year 1 passed the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of this evaluation are described below.

Teacher Content Knowledge
The evaluators followed an experimental design to assess whether geometry, probability and statistics knowledge was greater among 50 teachers who were randomly assigned to participate in SEE Math as compared with 49 teachers who did not participate in the program. Geometry, probability and statistics knowledge was tested using subscales of the Diagnostic Teacher Assessments in Mathematics and Science (DTAMS) assessment. The researchers found that post-test scores in geometry were comparable between treatment and comparison teachers, and that post-test scores in probability and statistics were significantly higher among comparison teachers.

Rice Regional Collaborative for Excellence in Science Teaching

State (APR) ID: Texas (TX100512)
Partners:
Project Director: Carolyn Nichol
Number of Participants: 168 grade 3–5 grade teachers and 70 secondary school teachers

Background:
The mission of the Rice Regional 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 ultimate aim is to assist science teachers in grades 3-12 to ensure that all students have authentic science learning experiences and that technology is fully integrated into instruction.

Description of Professional Development:
The Rice Regional Collaborative offers three distinct models of professional development. The Rice Elementary Model Science Lab (REMSL) and the Rice Model After-School Support (RMASS) are both year-long science programs for grade 3–5 teachers. While both programs offer support in science content knowledge, instructional strategies, and leadership, REMSL occurs one full day per week for the entire academic year, whereas RMASS convenes teachers after school once a week. The Rice Model for Advanced Inquiry Science (RMAIS) works with secondary teachers to improve their chemistry and physics knowledge in alignment with state and district standards. RMAIS teachers also visit university research labs to study new developments in science and engineering.

All Rice participants receive lab sessions, ongoing campus support visits from the Rice instructional team, a set of state standards-aligned online curriculum resources, and material resource kits. They have access to a peer mentoring program and a student observation lab. Since 2006, the collaborative has trained more than 600 elementary science teachers.

Description of Evaluation with Rigorous Design:
This evaluation followed an experimental design in which some schools were randomly selected to host the Rice Regional Collaborative while other schools did not have the program. The evaluation of *teacher content knowledge* for the REMSL program among teachers in grades 3 to 5 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
The evaluators assessed whether increases in pedagogical content knowledge were greater among 89 teachers who participated in the Rice Regional Collaborative than 29 comparison teachers who did not participate in the program. Teacher content knowledge was tested using the *Teacher Science Content Test*, which was developed by the evaluator from the 8th grade Texas Assessment of Knowledge and Skills (TAKS). Test scores among teachers who participated in the Collaborative increased more than for teachers who did not participate, but the difference was not found to be significant.

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). Through these partnerships, the MSP program seeks to provide intensive content-rich professional development to teachers and other school staff, 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 2010 (PP10), 566 individual MSP projects were in operation throughout the country. These projects provided professional development to nearly 44,000 educators who taught over 2.1 million students. 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. Nearly 3,300 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 PP10 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 100 hours of professional development. Two 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 PP10 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 (66 percent), followed by locally developed tests (39 percent). The use of assessments to measure teacher content knowledge in science was more balanced between standardized and locally developed tests, with 55 percent of assessments used locally developed and 44 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 (65 percent) who were assessed in mathematics showed significant gains in their content knowledge, and nearly three-fourths of teachers (74 percent) who were assessed in science showed significant gains in their content knowledge.

The proportion of students taught by MSP teachers who scored at the proficient level or above in state assessments of mathematics or science remained strong in PP10. In mathematics, 65 percent of students scored at the proficient level or above. In science, the proportion of students scoring the proficient level or above was 63 percent.

As they work to determine the impact of their programs, many projects are attempting to implement rigorous evaluation designs. Two percent of projects reported using experimental designs, and 45 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 to make them more closely aligned to the review standards used by the What Works Clearinghouse (see Appendix B). The criteria were applied to the final evaluation reports of the 113 projects that completed an experimental or comparison group design and submitted complete data. Fifteen of these projects met the rigorous criteria, which represents a five-fold increase from PP08. These fifteen 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 evaluating their programs using an experimental or quasi-experimental design. This review sought to determine the extent to which projects successfully conducted rigorous evaluations to yield findings that could be considered to be reliable and valid. To this end, we assessed how project evaluations, as reported in written project evaluation reports, aligned with 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 for improving future MSP project evaluations.

Methodology Used for Review

The primary source of information for the review was the final evaluation report for each project, supplemented by information provided in the Performance Period 2010 (PP10) annual performance reports (APRs). If projects were missing information needed to determine whether or not the project met the rubric criteria, reviewers requested the specific missing information from project staff. If the project staff did not return information that allowed reviewers to complete the review, the project was classified as not meeting the rubric criteria.

The review process proceeded in two stages by:

1. Defining the set of projects for review by identifying those that were in their final year of funding and whose evaluations met specific criteria for inclusion; and

2. Assessing and scoring project evaluations against a rubric to assess data quality and rigor in the 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 A.1). Out of the 566 projects funded in PP10, only the 218 projects that reported that PP10 was the final year were reviewed.

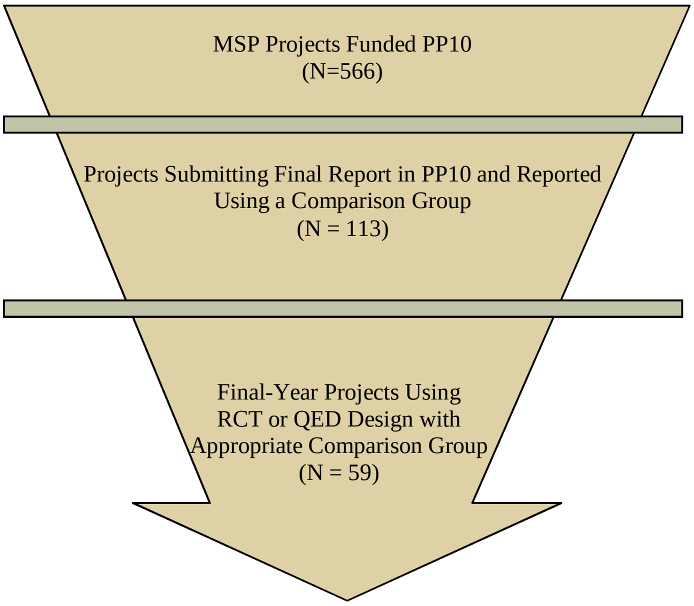
Because the purpose of the review was to learn about projects' impact evaluations, we limited our assessment to those who reported using experimental or quasi-experimental designs, both of which are considered to be appropriate for testing the impact of a program or intervention.[24] Experimental designs, 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 comparison group. Evaluations with quasi-experimental designs (QEDs) also include a treatment and comparison group, but the units of analysis are not randomly assigned to the groups. Focusing only on projects that reported using one of these two designs narrowed the set of projects for review from 218 to 113.

We further narrowed the set of projects to 59 by excluding those which did not have an evaluation report (19 projects), or which on closer review were not in the final year (10 projects) or did not

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

report a comparison group (25 projects). While 25 projects were presented as having an experimental or quasi-experimental design, we found on closer review that they did not use an appropriate comparison group. For example, some projects evaluated pre- and post-test scores for only a treatment group, or compared treatment group scores to established benchmarks, which contained scores from treatment group students. The remainder of the discussion in this appendix focuses on what we learned from reviewing these 59 projects.

Exhibit A.1: Sample of MSP Projects



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

Most of the reviewed MSP reports contained separate evaluations of various domains within the same report. Reviewed domains were those with strong theoretical links to MSP's goals, including teacher content knowledge, teacher classroom practices, and student achievement. If a project conducted research on more than one of these three domains, it was considered to have conducted multiple "evaluations." For example, a report might examine the effect of MSP on teacher content knowledge *and* the effect of MSP on student achievement. Of the 59 projects, 7 projects had evaluations in all three domains, 25 projects had evaluations in two domains (the most common being teacher content knowledge and student achievement), and the remaining 27 projects had an evaluation in only one domain. Across the final set of 59 projects, the majority had at least one evaluation in student achievement (49 projects), followed by teacher content knowledge (38 projects) and classroom practices (11 projects). The approach we used to assess the rigor of the evaluations is described below.

Assessing MSP Evaluations for Rigor

Documents provided from each of the remaining 59 projects were reviewed more closely to determine the extent to which the evaluations followed the recommendations for 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 PP10 in order to improve the alignment with the review standards used by the What Works Clearinghouse (see Appendix B).[25] The criteria specified in the rubric used for assessing the PP10 MSP evaluations were:

1. Data reduction rates;
2. Baseline equivalence;
3. Use of valid and reliable (or sufficiently tested) measurement instruments; and
4. Reports of relevant statistics.

To pass the rubric, evaluations had to satisfy the requirements of each criterion. Of the 59 projects reviewed, 15 projects successfully met all of the rubric's criteria. One of the projects in the final set was classified as not meeting the rubric criteria because the project staff did not return requested information needed to complete the review.

Of these 15 projects that met the rubric criteria, 3 were experimental studies and 12 were quasi-experimental. Five projects had evaluations that passed the rubric criteria in two domains, while one project had evaluations that passed in all three domains. In total, 5 of the 15 passing projects examined interventions' impacts on student achievement; 13 examined impacts on teacher content knowledge; and 4 examined impacts on classroom practices. In the review that follows, we present the rubric's four criteria and present recommendations for future project evaluations.

Assessing Comparability of Treatment and Comparison Groups

The first two criteria were 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 program studied rather than alternative explanations, confounding factors, or biases. Group comparability was examined differently for experimental and quasi-experimental studies.

For ***experimental studies***, the random assignment to treatment and comparison groups helps to ensure that there are not systematic differences between the two groups at baseline. However, attrition over the period of the evaluation may alter the composition of the treatment or comparison group, or the comparability of the groups. If attrition, also known as data reduction rates, between the assessment points of the evaluation is high, then the baseline equivalence between the treatment and comparison groups must be tested. Thus, to ensure treatment and control group comparability, we first check attrition by calculating *data reduction rates,* and if studies do not meet this criterion, we then examine *baseline equivalence* of the final sample used for analysis.

[25] For PP10, use of consistent methods, procedures and time frames to collect key outcome data from the treatment and comparison groups was not included as a criterion. Projects typically did not report on this, and projects that did not meet this goal were unlikely to meet the four criteria outlined above. This modification is in addition to changes made in the PP09 review. In that year, 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 ***quasi-experimental studies***, since units of analysis are not randomly assigned to treatment and comparison groups, evaluators must assess the differences between the groups at baseline in order to demonstrate whether or not the groups are comparable. Groups were considered to be comparable if there were no significant differences in 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.

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. In order to pass, 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.

Justification. Significant sample attrition can bias the evaluation 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 comparison groups, which can create systematic differences between the groups.

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

1. Present evidence that the overall attrition rate was less than 30 percent. Overall attrition refers to the attrition in the full sample (i.e., the participants in the two groups being compared to one another combined). AND

2. Present evidence that the difference in the attrition rates in the treatment and control groups was 15 percent or less.

When attrition rates were not provided in the evaluation, we calculated attrition rates by subtracting the post-test sample size from the pretest sample size and dividing by the pretest sample size. If an evaluation failed to provide this information and passed all other criteria, coders contacted the project director for the information required to calculate attrition.

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.

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 that demonstrate baseline equivalence of groups 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.

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.

Quality of Measurement Instruments

Description. A third crucial component of a rigorous evaluation design requires the use of 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).

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.

Relevant Statics Reported

Description. The final component of our review 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).

4.3 If other statistics are provided that indicate the significance and nature of the impact (e.g. effect sizes and impact estimates may substitute for post-test means and standard deviations/standard errors).

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 PP10 is helpful for understanding which elements of the rubric future projects may need additional guidance on when implementing their evaluations.

Finally, as Exhibit A.2 indicates, the number of projects with at least one evaluation passing all rubric criteria increased four-fold from PP07 to PP09. While the number decreased slightly in PP10, among projects that implemented comparison group designs, the fraction that met all rubric criteria remained the same between PP09 and PP10 (25 percent).

In the past four 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 between PP07 and PP09 can be attributed to a change in the criteria used to assess final-year evaluations in PP09,[26] the larger difference is due to the fact that more projects

[26] 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.

implemented more rigorous evaluation designs. The rate at which projects implemented rigorous evaluation designs was maintained in PP10.

Exhibit A.2: Number and Percent of Projects that Implemented Comparison Group Designs and Met all Rubric Criteria, Performance Periods 2007–2010

Projects	PP07	PP08	PP09	PP10
Implemented comparison group designs	37	49	65	59
Included at least one evaluation that passed all rubric criteria	4	3	16	15
Percent of projects with at least one passing evaluation	11%	6%	25%	25%

Local projects face many challenges in implementing rigorous designs, including such issues as limited resources, difficulties identifying reasonable comparison groups, and difficulties retaining 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 were presented in Appendix A.

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)[27]

❒ **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

27 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).

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, as defined below, between treatment and comparison group participants in the analytic sample on the outcomes studied, or on variables related to the study's key outcomes. Two groups are considered to have baseline equivalence when:

- 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); *or*

- 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, as defined above, between treatment and comparison group participants in the analytic sample on the outcomes studied, or on variables related to the study's key outcomes.

❒ **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) and the ncessary information was not provided such that reviewers could calculate it themselves.

❒ **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. 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); or provides results from clearly specified statistical models.

- ❒ **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); or provides results from clearly specified statistical models.

- ❒ **Did not address the criterion**

Appendix C: 2010 State MSP Appropriations

MSP appropriations to states ranged from $744,840 up to $17,876,173, with an average of $2,807,472 and a median of $1,703,516.

Exhibit C.1: MSP Appropriations to the States

State	Total Funding Amount	State	Total Funding Amount
AK	$744,840	MT	$744,840
AL	$2,685,939	NC	$4,733,183
AR	$1,611,191	ND	$744,840
AZ	$3,410,418	NE	$744,840
CA	$17,876,173	NH	$744,840
CO	$1,699,715	NJ	$2,538,055
CT	$887,579	NM	$1,269,260
DC	$744,840	NV	$1,162,496
DE	$744,840	NY	$8,036,036
FL	$8,120,268	OH	$5,268,605
GA	$5,260,953	OK	$1,896,140
HI	$744,840	OR	$1,543,635
IA	$940,605	PA	$4,561,474
ID	$744,840	PR	$4,680,092
IL	$5,282,424	RI	$744,840
IN	$2,899,118	SC	$2,330,551
KS	$1,048,080	SD	$744,840
KY	$2,210,718	TN	$3,273,638
LA	$2,550,206	TX	$15,226,261
MA	$1,707,316	UT	$1,151,366
MD	$1,470,908	VA	$2,231,272
ME	$744,840	VT	$744,840
MI	$4,663,571	WA	$2,324,644
MN	$1,603,345	WI	$2,097,051
MO	$2,412,599	WV	$823,952
MS	$2,071,960	WY	$744,840