



**Mathematics and  
Science Partnerships:  
Summary of  
Performance Period  
2011 Annual Reports**

**Analytic and  
Technical Support  
for Mathematics  
and Science  
Partnerships**

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**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<sup>1</sup> 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 2011, grants to states totaled \$175 million.

### Performance Period 2011 Mathematics and Science Partnerships

This report presents an overview of the MSP program during Performance Period 2011 (PP11),<sup>2</sup> 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 PP11, federal MSP resources totaling \$175 million were distributed to the 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.<sup>3</sup> State grants ranged from approximately \$870,000 up to \$20 million with an average of \$3.3 million and a median of \$2.1 million. In turn, the states funded a total of 499 local MSP projects, with local grants ranging from approximately \$37,000 to over \$9.3

<sup>1</sup> 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.

<sup>2</sup> Performance Period 2011 (PP11) refers to the period between October 1, 2011 and September 30, 2012.

<sup>3</sup> 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.

million with a median project grant of just over \$221,000 and a mean of approximately \$341,000. As shown in Exhibit ES.1, most projects (84 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: Sub-Grant Budgets from State MSP Grants, Performance Period 2011**

Project Budgets	Percent of Projects (N=499)
\$100,000 or less	12%
\$100,001 to \$200,000	34
\$200,001 to \$500,000	38
\$500,001 to \$1,000,000	14
\$1,000,001 or more	3

Source: Annual Performance Report item I.A.6  
The non-response rate was 0 percent in PP11.

**Participant Selection**

In selecting schools and teachers to participate in the MSP program, MSP projects could target either individual teachers or whole schools. Most MSP projects (86 percent) in PP11 targeted individual teachers in their professional development interventions. The remaining 14 percent of projects indicated that their professional development models were designed to improve mathematics and/or science instruction throughout a school, or a set of schools.

When asked about the main goal of their MSP project, nearly three-quarters of projects (73 percent) indicated that it was to improve individual teachers’ content knowledge, while only 2 percent reported that it was training teacher leaders who would in turn train other teachers. Twenty-two percent of projects reported that both goals were equally important, indicating that most projects that train teacher leaders also train individual teachers.

**Characteristics of Project Participants**

Nearly three thousand faculty members from IHEs were involved with MSP projects in PP11, 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, engineering, or technology. Additionally, two-thirds of the projects (67 percent) reported working with faculty members from education departments within IHEs.

Over 43,000 elementary, middle, and high school teachers, coaches, paraprofessionals and administrators participated in MSP projects in PP11. The number of these participants served by individual MSP projects ranged widely from 7 to 1,781, with typical projects serving 45 participants. These participants, in turn, taught over 2.4 million students.<sup>4</sup>

Eighty-six percent of MSP participants were regular classroom teachers of core mathematics and/or science content. In order of prevalence, the remaining 14 percent of participants included special

<sup>4</sup> Students may be included twice in this count, once as mathematics students and once as science students.

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. Among the individuals participating in MSP activities, 51 percent were employed at the elementary school level, 27 percent were at the middle school level, and the remaining 22 percent were at the high school level. Nearly three-fourths of projects (74 percent) targeted multiple school levels (i.e., some combination of elementary, middle, and/or high school); 40 percent served participants from all three school levels..

## **Professional Development Content, Models, and Activities**

### **Professional Development Content and Processes**

In PP11, 33 percent of MSP projects provided professional development in both mathematics and science; 41 percent provided professional development in mathematics only; and 26 percent provided professional development in science only.

Most MSP projects addressed multiple content areas and processes, both within and across disciplines. Across elementary, middle, and high schools, scientific inquiry was a frequently cited process taught (86 to 92 percent of projects that addressed science), while physical science was the most frequently cited science content area (64 to 69 percent), and chemistry was the least frequently addressed content area (44 to 46 percent). In mathematics, problem solving was a frequently addressed process taught across levels (85 to 87 percent of projects that addressed mathematics), while number and operations was the most commonly addressed content area in elementary school (82 percent), and algebra was the most frequently addressed content areas in middle and high school (79 percent and 80 percent, respectively). Calculus was the least frequently addressed topic (4 to 17 percent of projects that addressed mathematics).

### **Professional Development Models**

The MSP program legislation defines a summer institute as a model of professional development that provides intensive learning experiences over a minimum of a two-week period. As shown in Exhibit ES.2, nearly half of projects (47 percent) conducted summer institutes with school-year follow-up activities.<sup>5</sup> These projects reported offering a median of 104 hours of professional development. Just 2 percent of projects provided summer institutes only, with no follow-up. The remaining projects (51 percent) offered a broad range of professional development models, including onsite professional development, graduate courses, online coursework, and professional learning communities. Most of these projects also included a shorter summer component. The median length of professional development for these projects was 60 hours.

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<sup>5</sup> 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.

**Exhibit ES.2: Median Professional Development Hours, by Professional Development Model Type, Performance Period 2011**

Professional Development Model	Percent of Projects (N=499)	Total Median Hours
Summer institute only	2%	80
Summer institute with follow-up	47	104
Various other models	51	60

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.

**Professional Development Activities**

The professional development activities offered by MSP projects focus on increasing teachers' content knowledge in mathematics and/or the sciences and on enhancing their pedagogical skills. The most commonly reported model for delivering school-year activities was on-site professional development (68 percent of projects), followed by study groups (16 percent), content coursework at colleges or universities (7 percent), and on-line coursework/distance learning networks (2 percent).

**MSP Evaluation Designs and Outcomes**
**Evaluation Designs**

MSP projects reported the primary designs they used to assess program outcomes. One percent reported using an experimental design in which teachers, classrooms, or schools were randomly assigned to a treatment or control group. Another 49 percent of projects reported using a quasi-experimental design with a matched or non-matched comparison group. The remaining projects reported using less rigorous evaluation designs, such as: single-group design with pre- and post-tests (34 percent); qualitative or descriptive methods only (10 percent); or mixed quantitative and qualitative methods (6 percent).

The MSP program has been educating its projects by providing them with criteria for carrying out rigorous impact evaluations. 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 meeting all criteria increased four-fold from PP07 to PP09 and the proportion of passing projects continues to rise.

**Exhibit ES.3: Final Year Projects that Conducted Rigorous Evaluations and Met MSP Criteria for Rigor, Performance Periods 2007–2011**

Projects	PP07	PP08	PP09	PP10	PP11
Implemented comparison group designs	37	49	65	59	59
Included at least one evaluation that met all criteria	4	3	16	15	17
Percent of projects with at least one passing evaluation	11%	6%	25%	25%	29%

**Teacher Content Knowledge Outcomes**

Federal regulations require that all teachers who receive MSP funded professional development are pre- and post-tested at least once during the life of a project. As shown in Exhibit ES.4, roughly half of teachers who received professional development in mathematics and science were tested using pre- and post-assessments in PP11 (45 percent in mathematics and 58 percent in science). Sixty-one percent of teachers who were assessed in mathematics and over 69 percent of teachers who were assessed in science showed statistically significant gains in their content knowledge.

The most frequently reported assessments of teacher content knowledge in mathematics were nationally normed/standardized tests (69 percent of projects). Projects that did not use nationally normed or standardized content assessments often developed their own assessments for their MSP projects. Nearly one third of projects (31 percent) used locally developed tests to assess teacher gains in mathematics content knowledge. In science, the most frequently used instruments were locally developed tests (60 percent of projects), followed by standardized instruments (42 percent).

**Exhibit ES.4: Percent of Teachers with Significant Gains in Content Knowledge, Among Teachers with Pre-Post Content Assessments, Performance Period 2011**

Content Area	Total Number of Teachers Served	Percent of Teachers with Content Assessments	Percent of Assessed Teachers with Significant Gains
Mathematics	23,807	45%	61%
Science	16,042	58	69

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 50 percent of students with assessment data in mathematics, nearly two-thirds (64 percent) scored at the proficient level or above. Similarly, among the 29 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 PP11, 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 2011**

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	1,407,724	50%	64%
Science	814,751	29	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 PP11, almost all MSP projects (94 percent) that measured student achievement in mathematics used state assessments. In science, 57 percent of projects that measured student achievement in science used state assessments. Projects also commonly reported utilizing locally developed tests (50 percent) in science.

**Conclusions**

The MSP Program is successfully implementing the requirements of the law. Partnerships are being formed between STEM and education departments at IHEs and high-need local educational agencies, and many of these partnerships also include public or private schools, businesses, and non-profit or for-profit organizations. Teachers are receiving intensive and sustained content-rich professional development—from college and university faculty partners and other professionals—that integrates mathematics and science content with effective pedagogical strategies. Many of these teachers have the additional advantage of receiving ongoing mentoring and coaching from faculty and master teachers as they begin to implement their new knowledge and practices in their classrooms. Furthermore, many projects are collecting data on what teachers are learning and are conducting rigorous impact evaluations.

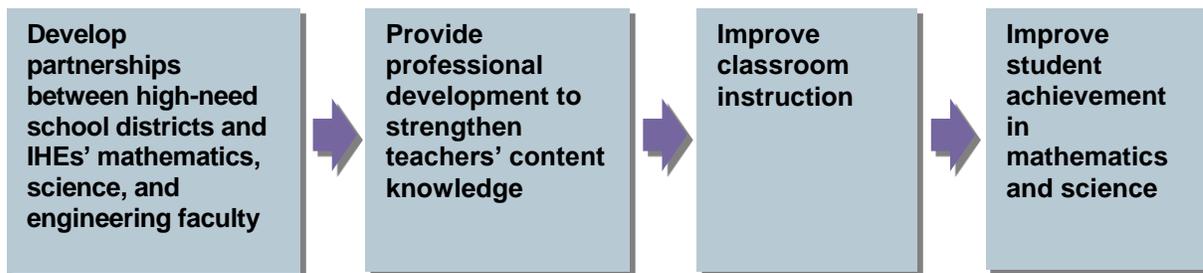
In PP11, over 5,000 local educational agencies (LEAs), organizations, and institutions—involving nearly 3,000 IHE faculty members—partnered to form 499 projects across the country. Projects served over 43,000 educators nationwide, with each educator receiving an average of 80 hours of professional development, thus enhancing the quality of classroom instruction for over 2.4 million students. Based on this professional development, 61 percent of teachers who were assessed in mathematics and 69 percent 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 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

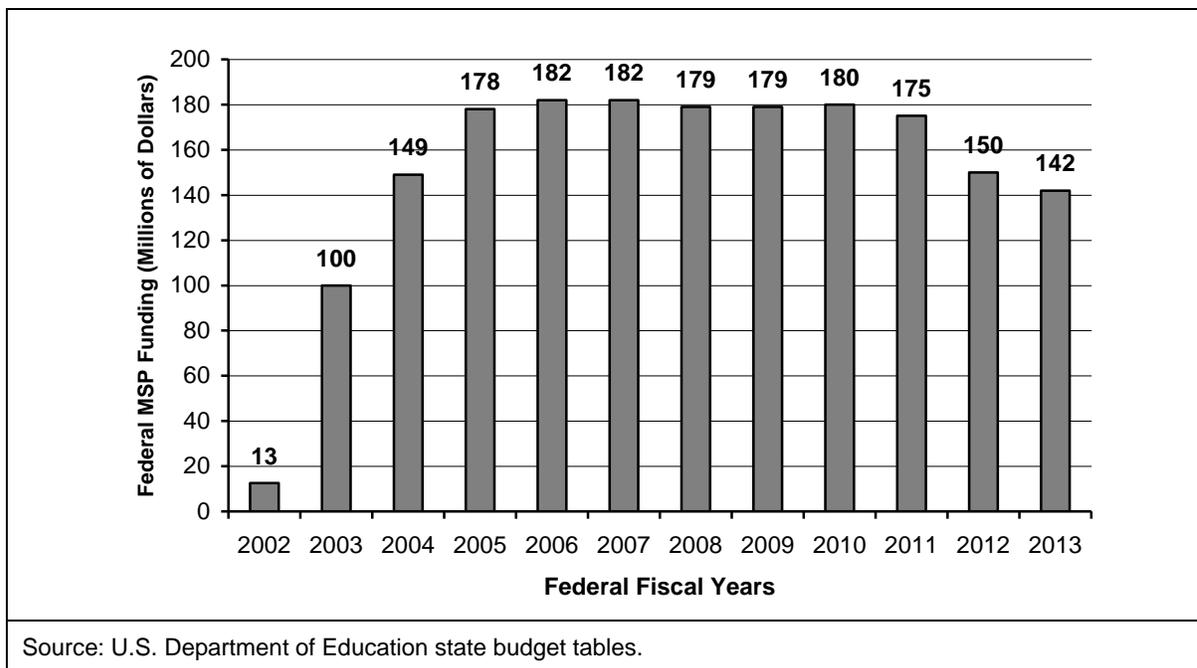
Implemented under the *No Child Left Behind Act of 2001, Title II, Part B*, the MSP program is strategically designed to improve the content and pedagogical knowledge of teachers and the academic performance of students in mathematics and science. The MSP program is a formula grant program to the states, 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 that are made up of, at a minimum, high-need schools or school districts<sup>6</sup> and science, technology, engineering, and mathematics departments in IHEs. Other partners may include additional local education agencies, public or private schools, and businesses and non-profit or for-profit organizations.

<sup>6</sup> 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 increased further between 2005 and 2011, during which time total funding for the program hovered around \$180 million annually. In the past two years, funding has decreased slightly.

In FY 2011, the period described in this report, states awarded \$175 million in funds to 499 local partnerships (sub-grants). State grants for FY 2011 ranged from approximately \$870,000 up to \$20 million with an average of \$3.3 million and a median of \$2.1 million. These grants 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.<sup>7</sup>

**Exhibit 2: MSP Program Funding, Fiscal Years 2002–2013**



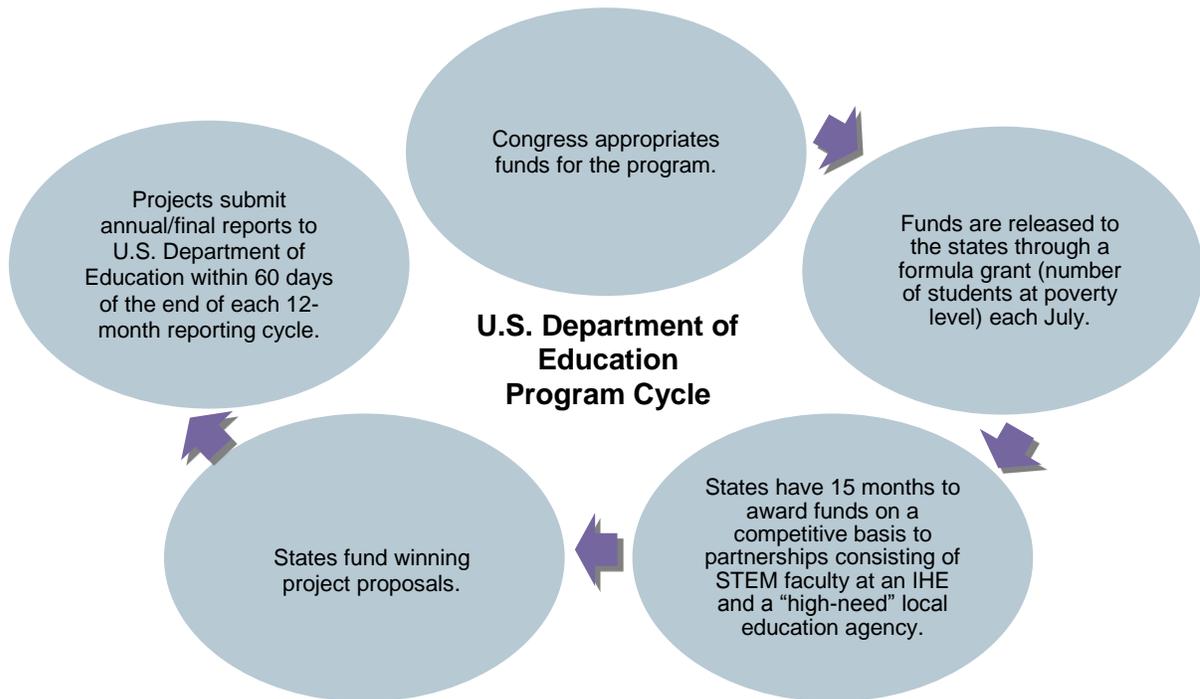
The administration of the MSP program involves an annual cycle of activities conducted at the federal, state, and local agency levels (see Exhibit 3). Each July, the Department of Education is charged with distributing MSP program funds to state education agencies for the upcoming fiscal year, based upon the number of children aged 5 through 17 years old in the state who live 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.<sup>8</sup>

<sup>7</sup> 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.

<sup>8</sup> The American Virgin Islands, Guam, Northern Mariana Islands, and Samoa pool their MSP funds as part of their consolidated budget.

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 to report annually to the U.S. Department of Education. Projects 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 2011 (PP11).<sup>9</sup> The findings presented in this report are primarily based on annual performance report (APR) data

<sup>9</sup> Performance Period 2011 (PP11) refers to the period between October 1, 2011 and September 30, 2012. PP11 projects are those for which the majority of months of activities described in the Annual Performance Report take place in the 2011 fiscal year, between October 1, 2011 and September 30, 2012.

submitted by all MSP projects by February 28, 2013.<sup>10</sup> Additionally, to examine trends in the MSP program over time, data from previous years are also included for some APR items. The report includes findings on a few selected APR items from previous periods beginning in PP04 when the first APRs were submitted. However, for most items, trends are only examined over the past three years. Since there is substantial turnover in the set of projects included in the analyses for each year, the findings should not be thought of as longitudinal. Thus, we would not necessarily expect to see growth over time, as new projects are continually added to the program and other projects are ending.

The analyses were guided by five research questions (Exhibit 4). The first four research questions are addressed through the use of simple descriptive statistics, such as means and percentages from closed-ended questions 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 item responses 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**

<b>RQ1</b>	How are MSP projects implemented?
<b>RQ2</b>	Do MSP projects report using rigorous designs, such as experimental or quasi-experimental designs, for their evaluations?
<b>RQ3</b>	Do teachers that participate in the MSP program increase their scores on assessments of content knowledge?
<b>RQ4</b>	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?
<b>RQ5</b>	Do MSP projects using an experimental or quasi-experimental design for their evaluations conduct their evaluations successfully and do they yield scientifically valid results?

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<sup>10</sup> These primarily included PP11 reports, but they also included some PP10 reports for which teacher and/or student data were not available in time to submit during the previous year.

## Report Organization

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

Chapter 2: Characteristics of MSP Projects and Participants

Chapter 3: Professional Development Content, Models, and Activities

Chapter 4: MSP Evaluation Designs and Outcomes

Chapter 5: Highlights from PP11 MSP Projects with Rigorous Designs

Chapter 6: Summary and Conclusions

Appendix A: Review of Projects with Rigorous Designs

Appendix B: Criteria for Classifying Designs of MSP Evaluations

Appendix C: 2011 State MSP Appropriations

Chapters 2 and 3 describe how MSP projects were implemented. Chapter 4 describes the designs and outcomes projects reported. Chapter 5 presents highlights from PP11 MSP projects that implemented rigorous evaluations. Finally, Chapter 6 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 presents a table with the 2011 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 PP11, federal MSP resources totaling \$175 million were distributed through formula grants to all 50 states, the District of Columbia, Puerto Rico, and U.S. Island areas.<sup>11</sup> No state received less than one half of one percent of the total appropriation; MSP appropriations to individual states ranged from \$871,257 to \$20.1 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 \$36,981 to \$9.3 million with an average of \$341,322 and a median of \$221,539. As shown in Exhibit 5, over three-fourths of projects (78 to 86 percent) received an award of \$500,000 or less between PP05 and PP11. The size of awards in PP11 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 2005–2011**

MSP Awards	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)	PP11 Percent of Projects (N=498)
\$100,000 or less	20%	17%	9%	13%	13%	12%	12%
\$100,001 to \$200,000	29	37	43	38	37	36	34
\$200,001 to \$500,000	32	26	26	30	36	37	38
\$500,001 to \$1,000,000	14	15	18	17	13	12	14
\$1,000,001 or more	5	5	4	2	1	3	3

Source: Annual Performance Report item I.A.6  
 The non-response rate was 9 percent in PP05, 1 percent in PP06, <1 percent in PP07, 0 percent in PP08, <1 percent in PP09, 0 percent in PP10, and <1 percent in PP11.

<sup>11</sup> 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.

Some MSP projects supplemented their federal MSP funds with funds from other federal and non-federal sources. In PP11, 7 percent of projects reported receiving funds from other sources. These additional funds ranged from \$1,000 to \$500,000.

### 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 institution of higher education (IHE), as seen in Exhibit 6. 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 a local school district nor an IHE served as the lead organization. In PP11, other designated fiscal agents for the projects primarily included regional organizations (11 percent) and non-profit organizations (3 percent).

**Exhibit 6: Types of Lead Organizations, Performance Periods 2005–2011**

Type of Lead Organization	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)	PP11 Percent of Projects (N=499)
Local school district	54%	53%	56%	50%	47%	44%	45%
Institution of higher education (IHE)	29	31	31	37	35	39	40
Non-profits, regional educational agencies, or other organizations	17	16	13	13	18	18	15

Source: Annual Performance Report item I.B.3  
 The non-response rate was 0 percent in PP05, 1 percent in PP06, 0 percent in PP07, 0 percent in PP08, 0 percent in PP09, 0 percent in PP10, and 0 percent in PP11.

The MSP program establishes local partnerships that include: 1) a science,<sup>12</sup> technology, engineering and/or mathematics department of an IHE and 2) a high-need school district. In addition, , MSP projects may incorporate other types of partners such as: education departments from IHEs; additional local education agencies including public charter schools, public or private elementary or secondary schools, and school consortia; and businesses and non-profit or for-profit organizations that have a proven capacity to effectively improve the knowledge of mathematics and science teachers. MSP

<sup>12</sup> Computer science is included with science departments.

projects reporting in PP11 had a median of 5 partner organizations, with the number of partners ranging from 1 to 343.

In PP11, 2,942 IHE faculty members, working in a variety of disciplines, were involved with MSP projects. As shown in Exhibit 7, half or more of all projects included faculty from science (54 percent) or mathematics (65 percent) departments; 15 percent of projects included faculty from engineering departments; and 9 percent of projects included faculty from technology departments. Additionally, two-thirds of the projects (67 percent) reported working with faculty members from education departments, and 12 percent of projects included faculty from “other” departments, such as economics, 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 2011**

Discipline	Percent of Projects (N=499)	Average Number per Project, Among Projects with Participating Faculty	Total Number Participating in MSP (Sum=2,942)
Science <sup>1</sup>	54%	4	1,006
Mathematics	65	3	882
Engineering	15	2	181
Education	67	2	755
Technology	9	2	71
Other	12	2	118

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.  
<sup>1</sup>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 having all components of the project’s planned model fully operational. Exhibit 8 shows that in PP11, more projects reported being fully developed or developing than new (56 percent, 28 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 2009–2011**

Stage of Implementation	PP09 Percent of Projects (N=588)	PP10 Percent of Projects (N=566)	PP11 Percent of Projects (N=497)
Stage 1: New	17%	16%	16%
Stage 2: Developing	36	34	28
Stage 3: Fully developed	47	50	56

Source: Annual Performance Report item VII.C  
The non-response rate was <1 percent in PP09, 0 percent in PP10, and <1 percent in PP11.

**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 over 43,000 participants in PP11, including elementary, middle, and high school teachers, coaches, paraprofessionals, and administrators (Exhibit 9). This number represents a slight decrease in the number of participants served from previous years. The median number of participants served per project has remained relatively stable over the years.<sup>13</sup> The number of participants reported by individual projects varied widely, ranging from a low of 7 participants to a high of 1,781. Nearly all projects (92 percent) worked with 200 participants or fewer. Over half of the projects (58 percent) reported serving 50 or fewer participants in PP11; 25 percent reported serving between 50 and 100 participants; and the remaining projects (18 percent) reported serving more than 100 participants.

<sup>13</sup> A median of 45 means that half of reporting MSP projects served 45 or fewer participants, and half served more than 45 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 2009–2011**

Number of Participants Served	PP09 (N=585)	PP10 (N=566)	PP11 (N=499)
Total number served by MSP projects	48,950	43,755	43,146
Median number served per project	42	41	45
Minimum number served per project	6	5	7
Maximum number served per project	1,423	1,200	1,781
25 or fewer	20%	20%	20%
26–50	42	39	38
51–100	20	24	25
101–200	10	10	10
201 or more	8	7	8
Source: Annual Performance Report items IV.C, IV.G.1			
The non-response rate was <1 percent in PP09, <1 percent in PP10, and 0 percent in PP11.			

**Methods of Selecting Participants**

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

As shown in Exhibit 10, most MSP projects (86 percent) in PP11 targeted individual teachers in their professional development interventions. The remaining 14 percent of projects indicated that their professional development models were designed to improve mathematics and/or science instruction throughout a school, or a set of schools. Among projects that targeted schools, almost all reported serving regular public schools (98 percent), with only a few serving public charter, private, or other types of schools (2 percent). More than half of these schools (56 percent) had schoolwide Title I status; and 71 percent of schools 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 2011**

Primary Target	Percent of Projects (N=499)
Individual teacher	86%
Schools (one school, schools within a district, or schools across district lines)	14%
Source: Annual Performance Report item IV.B.2	
The non-response rate was 0 percent.	

Nearly three-quarters of projects (73 percent) indicated that the main goal of their MSP project was to improve individual teachers' content knowledge, while only 2 percent had the main goal of training teacher leaders who would in turn train other teachers (Exhibit 11). Twenty-two percent of projects reported that both goals were equally important, indicating that most projects that train teacher leaders also train individual teachers. An additional 3 percent of projects reported another type of main goal, such as sustainability and documentation activities, pedagogy, and facilitating teacher certification.

**Exhibit 11: Main Goal of MSP Project, Performance Period 2011**

Main Goal	Percent of Projects (N=499)
Improving teachers' content knowledge	73%
Training teacher leaders	2
Both improving teachers' content knowledge and training teacher leaders	22
Other	3

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

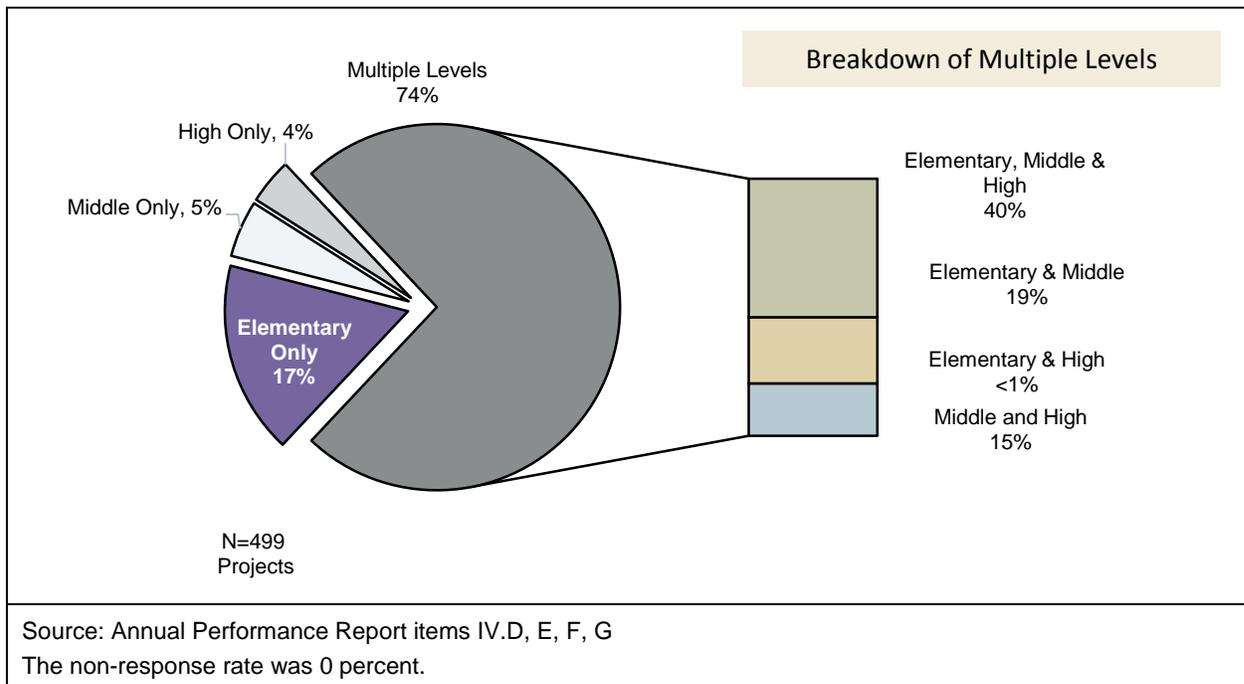
**School Levels and Types of Participants Served**

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 school levels, or participants from the entire K–12 spectrum. Overall, in PP11, 74 percent of projects worked with participants from multiple school levels, while 26 percent of projects targeted a single school level.

As shown in Exhibit 12, 17 percent of all MSP projects in PP11 targeted the elementary school level only, 5 percent targeted the middle school level only, and 4 percent targeted the high school level only. Among projects targeted multiple school levels, 40 percent of projects targeted participants at all school levels; 19 percent targeted elementary and middle school participants; 15 percent targeted middle and high school participants; and less than 1 percent targeted elementary and high school participants.

MSP participants were distributed across school levels in PP11 as follows: 51 percent at the elementary level, 27 percent at the middle school level, and 22 percent at the high school level. This distribution has remained fairly stable over recent years.

**Exhibit 12: School Levels of Participants Served, Performance Period 2011**



The MSP projects serve a variety of educators at all 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, 85 to 86 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 (4 percent).

**Exhibit 13: Percent of Teachers and Other School Staff Among All MSP Participants Served, by School Level, Performance Period 2011**

Participant Type	Percent of Teachers and Other School Staff Served		
	Elementary School (K-5) (N=21,990)	Middle School (6-8) (N=11,623)	High School (9-12) (N=9,169)
Regular core content teachers	86%	85%	85%
Special education teachers	5	6	5
School administrators	4	4	4
Math coaches	1	1	1
Science coaches	<1	<1	<1
ELL teachers	2	1	1
Gifted and talented / AP-IB teachers	1	2	4
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 2.4 million students in PP11. Exhibit 14 shows the total number of students at each school level who were taught by MSP participants, as well as the median<sup>14</sup> number of students reached by MSP participants.

**Exhibit 14: Total Number of Students Taught by Participants in MSP Projects, Performance Period 2011**

Number of Students Taught	Elementary School (N=353 Projects)	Middle School (N=361 Projects)	High School (N=270 Projects)
Total number taught by MSP participants	648,214	997,976	774,755
Median number taught per project	789	1,081	1,200

Source: Annual Performance Report items IV.H  
 The non-response rate was 7 percent.  
 Projects could serve one or multiple school levels.

<sup>14</sup> 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 PP11, 41 percent of projects focused on mathematics only, 26 percent focused on science only, and 33 percent focused on both mathematics and science. Although the trend of more projects focusing on mathematics than on science has remained fairly stable over time, in PP11 the gap between the proportions of mathematics and science projects widened to 15 percent.

#### Exhibit 15: Content Focus of Professional Development, Performance Periods 2009–2011

Content Focus	PP09 Percent of Projects (N=581)	PP10 Percent of Projects (N=565)	PP11 Percent of Projects (N=496)
Mathematics only	39%	38%	41%
Science only	30	31	26
Mathematics and science	31	31	33

Source: Annual Performance Report items VI.A.1, VI.B.1  
The non-response rate was 1 percent in PP09, 0 percent in PP10, and 1 percent in PP11.

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 and Processes

Almost every MSP project provided professional development in multiple content areas and processes, 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 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 topic across all school levels (85 to 87 percent of projects), while number and operations was the most commonly addressed content area in elementary school (82 percent), and algebra was the most frequently addressed content area in middle and high school (79 percent and 80 percent,

respectively). Calculus was the least frequently addressed content area across all school levels (4 to 17 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 or processes. Additionally, 55 to 66 percent of projects addressed algebra, measurement, or geometry; over half of projects addressed geometry or reasoning and proof; and 42 percent of projects addressed probability and statistics.

At the middle school level, 85 percent of projects that involved math professional development addressed problem solving as one of their content areas or processes, and 70 percent or more of projects addressed algebra or number and operations. In addition, 62 percent of projects addressed technology and over half of projects addressed geometry, reasoning and proof, or measurement.

At the high school level, over four-fifths of projects that involved math professional development addressed problem solving or algebra as one of their content areas, and approximately two-thirds of projects addressed technology. Sixty-two percent of projects addressed number and operations. Additionally, over half of projects addressed reasoning and proof, geometry, probability and statistics, or measurement. Finally, 17 percent of projects addressed calculus.

**Exhibit 16: Content Areas and Processes of Mathematics Professional Development Provided to Teachers, by School Level, Performance Period 2011**

Mathematics Content and Processes	Elementary School Teachers Percent of Projects (N=258)	Middle School Teachers Percent of Projects (N=275)	High School Teachers Percent of Projects (N=211)
Problem solving	86%	85%	87%
Number and operations	82	70	62
Algebra	66	79	80
Geometry	55	56	57
Reasoning and proof	54	60	63
Measurement	63	58	51
Probability and statistics	42	50	53
Calculus	4	8	17
Technology	53	62	68
Other	22	20	27

Source: Annual Performance Report item VI.A.2  
 The total number of projects that provided professional development in mathematics content areas or processes in PP11 was 355. The non-response rate was 0 percent in PP11.  
 Percents total more than 100 percent because respondents could check more than one category. Projects could serve one or multiple school levels.

**Science Content and Processes**

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 and processes 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 a commonly addressed teaching method among projects across all school levels that addressed science (86 to 92 percent of projects), since it can be used across topics. Physical science and/or physics were the most commonly addressed content areas (86 to 92 percent) across all school levels, and chemistry was the least frequently addressed topic (44 to 46 percent). Many projects (65 to 67 percent) across all school levels provided professional development in technology.

At the elementary school level, 92 percent of projects that involved science professional development addressed scientific inquiry. Additionally, approximately two-thirds of projects addressed physical science, earth science, life science, or technology. Forty-four percent of projects serving elementary school teachers provided professional development in chemistry.

At the middle school level, 92 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 59 percent addressed earth science. Just under half of projects serving middle school teachers provided professional development in chemistry.

At the high school level, 86 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 2011**

Science Content Areas and Processes	Elementary School Teachers Percent of Projects (N=204)	Middle School Teachers Percent of Projects (N=214)	High School Teachers Percent of Projects (N=160)
Scientific inquiry	92%	92%	86%
Physical science/Physics	69	69	64
Life science/Biology	65	68	63
Earth science	66	59	45
Chemistry	44	46	46
Technology	66	65	67
Other	36	31	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 PP11 was 282. 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. Although improving teacher content knowledge directly through a summer institute with in-school follow-up is the most

common model of MSP professional development, most of the remaining projects also include shorter summer components in addition to school-year activities. In the following sections, we provide examples of project work describing a variety of professional development models. For more information about these projects, please contact the appropriate State Coordinator, whose contact information can be found on the public website ([www.ed-msp.net](http://www.ed-msp.net)).

### **Projects with Summer Institutes**

In PP11, nearly half of MSP projects (49 percent) conducted a summer institute. These learning experiences include deep exploration of mathematics and science content. Projects that offer summer institutes typically conduct 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 PP11, 47 percent of projects conducted summer institutes with school year follow-up activities, while only 2 percent 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 Oklahoma, the Pontotoc County-Forensic Applications of Content and Evidence in Science (PC-FACES) project used standards and education research on integrated learning to drive content, and immersed K–12 level science teachers in a 10-day summer institute including lecture, laboratory, simulator experiences, and field trips. The summer institute engaged teachers with biology professors, scientists, and a guest speaker on document forensics. Teachers engaged in laboratory sessions and utilized a crime simulator. Some of the field trips included the Forensic Science Institute and DNA Solutions, a private facility specializing in human and animal forensics. The summer institute integrated life, earth, and physical sciences with mathematics, literacy, technology, and research in the study of forensic science, connecting and reinforcing the content of previous projects. Ongoing mentoring was provided by professors and master teachers during the academic year through four follow-up Saturday sessions and additional interactions. (Cornelison, 2012)

The Vigo County Math MSP project in Indiana provided an intensive two-week summer institute in mathematics content knowledge with a focus on algebra and teaching methods based on scientific research, as well as follow-up embedded training during the school day. Faculty from Indiana University, the curriculum coordinator, and district specialists delivered professional development activities. Professional development included the integration of technology, kinesthetic activities, discussion, direct instruction, modeling and coaching, and collaborative work. Follow-up activities during the school year took place both during the school day and after school in two-hour blocks. Specific activities addressed included fostering algebraic thinking, cultivating habits of thinking, developing guidelines for assessing student achievement, determining mathematics areas targeted for improvement based on applied skills data, acuity alignment, developing learning problems, approaches for delivering services to students with special needs, designing hands-on classroom activities and manipulatives that utilize the Standards for Mathematical Practice, and developing on-line student resources. (Goeller, 2012)

**Exhibit 18: Types of Professional Development Models, Performance Period 2011**

Professional Development Model	Percent of Projects (N=499)
Summer institute only	2%
Summer institute with follow-up activities	47
Various other models	51
Source: Annual Performance Report item V.B The non-response rate was 0 percent.	

**Projects Offering Various Other Models of Professional Development**

The 51 percent of MSP projects that did not conduct a two-week summer institute in PP11 provided other types of professional development activities that primarily took place during the academic year, many of which also included a summer component. 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 half of projects (53 percent) reported offering between one and two weeks of professional development in the summer, while 27 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.<sup>15</sup> 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 are provided below.

The Alabama Math, Science, and Technology Initiative (AMSTI) project offered science module content training and GLOBE protocol training presented by certified AMSTI trainers during the school year. Specific activities included embedded science notebooking protocols, grade-level specific science kit training, and modeling of best instructional practices. These activities were directed by the state's AMSTI model for science training. The mechanisms for training included face to face training and an on-line module to outline the basics of science notebooking. Science notebooks were used to collect and analyze data, as well as to reflect on findings. The other component of the project involved embedded math coaching during the school day between program specialists and participating teachers. This model involved pre-conferencing, modeling lessons, co-teaching, and post-conferencing. (Hollis, 2012)

In North Carolina, an MSP project engaged teachers in physical science content knowledge sessions on Saturdays during the school year at an East Carolina University physics teaching laboratory. Topics chosen from newly developed North Carolina physical science standards were measurements and kinematics, forces and motion, work and energy, heat, and waves. Activities strengthened content knowledge and modeled inquiry-based methods. Techniques

<sup>15</sup> 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.

were inquiry-based labs using data acquisition systems and hands-on measurements with typical physics lab apparatuses. Teachers also received three days of curriculum unit development on content-session topics. Group discussions focused on inquiry-based teaching, introducing the 5E model for lesson development. After the school year, teachers implemented units in a five-day student-enrichment session for middle school students from the participating LEAs. Each teacher developed and taught one lesson of the unit. Teachers evaluated lessons using the Reformed Teaching Observational Protocol (RTOP). Teachers led debriefing sessions after each lesson, discussing strengths and weaknesses and suggesting revisions. The students were also debriefed after each lesson to provide feedback. This model provided teachers feedback from university faculty, peers, and students. (Oros, 2012)

### Hours of Professional Development Provided

Exhibit 19 shows the median number of hours of professional development<sup>16</sup> provided by model type. Among projects that conducted summer institutes only, a median of 80 hours of professional development were provided, and projects that focused on school year activities provided a median of 60 hours. Projects that conducted summer institutes with follow-up activities provided a median of 104 hours. When the time spent during the summer was analyzed separately from school-year activities, projects spent a median of 72 hours during the summer institute, and a median of 30 hours on follow-up activities.

**Exhibit 19: Median Hours of Professional Development, By Model Type, Performance Period 2011**

Professional Development Model	Median Number of Hours
Summer institute only	80
Summer institute with follow-up activities: <sup>1</sup>	104
<i>Summer institute portion</i>	72
<i>Follow-up activities portion</i>	30
Focus on school-year activities	60

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: 8 percent; and focus on school-year activities: <1 percent.  
<sup>1</sup> Medians are calculated separately within each category. Since the median for each category represents the middle number for that category, the medians for each type of follow-up do not necessarily 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 PP11. 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.

<sup>16</sup> Projects that provided a very high or very low level of professional development skewed the average (mean), so we present the median.

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 PP11 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 68 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 (8 percent) and on-line course work/distance learning networks (2 percent). Finally, 2 percent of projects reported that they were in planning phases and did not offer any professional development activities, while the remaining 4 percent of projects reported that they offered professional development activities that did not fall into one of the previously mentioned categories, such as field experiences, mentoring, conference attendance, or workshops.

**Exhibit 20: Primary Form of Professional Development Activities Provided by Projects, Other Than Summer Institutes, Performance Period 2011**

Primary Focus of Professional Development Activities	Percent of Projects (N=494)
On-site activities during academic year	68%
Study groups	16
University courses	7
On-line coursework/distance learning networks	2
Planning (no professional development activities)	2
Other activities (including field experiences, mentoring, conferences, workshops)	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, 68 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, institution of higher education (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 are employing on-site professional support.

In Alabama, the Greater Birmingham Mathematics Partnership (GBMP) professional development model includes summer courses, a Math Studio, individual classroom coaching, professional learning communities (PLCs), and family math nights. Teachers take week-long math content summer courses, and at course conclusion a leadership team develops an action plan for the upcoming academic year. The Math Studio is designed to accelerate the transformation of instructional practices in the classroom through individualized and collaborative work with the principal and teachers in a school. The structure is built upon the notion of de-privatizing classroom practice. In the Studio Model, the selected teacher teaches a pre-planned lesson to his/her students while the other teachers, administrators, and IHE mathematics faculty observe, and the GBMP Mathematics Coach does on-the-spot coaching while also talking with the observers about what is happening in the lesson. This “fishbowl” atmosphere allows teachers and administrators to observe in-the-moment teacher decision-making and coaching support. Individual coaching of all regular classroom teachers by the GBMP mathematics coach will occur between Math Studio cycles. Coaching is also designed to support implementation of the action plans developed in the previous studio cycle, and grade-level PLCs will be established with the support of the coach. Finally, two family math nights will be offered per year. (Mayer, 2013)

The Pennsylvania STEM Partnerships (PA STEM) project provided a two-week summer institute with follow-up activities throughout the school year including full-day and after-school sessions, and monthly science coaching. During the summer institute simultaneous math and science content strands were taught by Penn State faculty during the first week. The second week of the summer institute focused on Pennsylvania’s Standards Aligned System (PSSA) with differentiated math and science SAS strands, pedagogical content knowledge, valid and reliable research-based best practices and strategies, and project-based learning conducted by the Northwest Tri-County Intermediate Unit. Academic year follow-up included a full-day session on using the released PSSA results to guide implementation of summer institute content activities into the classroom. Six afterschool sessions were held that included guest speakers from regional organizations, the provision of education resources, and sharing of lesson plans. In addition, science coaches met monthly for face-to-face technical assistance as well as weekly phone or email consultation in support of lesson plan development and lesson progressions, units, and feedback. Coaches also assisted teachers in aligning and integrating resources in an intentional, multidisciplinary approach. (Schimshock, 2012)

### **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 promoted ongoing collaboration among staff.

The Kean University MSP in New Jersey engaged teachers in content-rich instruction during an intensive two-week summer institute in algebra or physics content. Teachers participated in hands-on and/or laboratory activities, data collection, and data analysis in small groups. Faculty also provided pedagogical lenses, for example common student misconceptions, through which teachers were encouraged to reflect on projected student interaction with the content. During the academic year teachers were guided in a modified Japanese Lesson Study during which they applied new or enhanced content from the summer institute in their own classrooms, evaluated the students' interaction with the material, and revised and redelivered the lessons. The culminating experience included a reflection on the Lesson Study with special emphasis paid to an analysis of student learning in the particular math or science topics, and a report-out to other Kean MSP teachers. Teacher and professional development providers supported one another in a secure on-line environment through an interactive PLC. Finally, teachers were given the opportunity to enroll in up to two hybrid courses at the American Museum of Natural History Seminars on Science series where they were to work with scientists and pedagogical experts at the museum. (Baldwin, 2012)

In Arizona, the PASS professional development included intensive and sustained content with science and engineering practices, focusing on physical science themes including energy, energy transfer, solar energy, force as an agent of energy transfer, and energy problems. Three Saturday sessions were conducted during the academic year to bring teachers together and form a community of practice, to begin a dialogue about the Next Generation Science Standards (NGSS), and to measure teacher content knowledge and pedagogical content knowledge. This was followed by an intensive three-week summer institute in which teachers learned to use science and engineering practices and design their learning environments and their curricula to optimize student thinking and learning. The focus for developing these practices was energy, an NGSS Crosscutting Concept that threads through the entire middle school earth, life, and physical sciences curricula. Teachers engaged in investigations and classroom discourse as their students would and reflected on the practical problems of classroom implementation in “teacher mode.” They did engineering design activities and worked in small groups to design an instructional unit that they will test during the coming academic year. They continue to use their on-line forum (Piazza) to communicate as they prepare for the upcoming school year. (Haag, 2013)

### **Content Course Work at a College or University**

With the goal of enhancing teachers' content knowledge, 8 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.<sup>17</sup> Below are descriptions from two projects that provided teachers the opportunity to attend university courses and earn graduate credits.

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<sup>17</sup> 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.

Aurora University (AU) developed and delivered master's degree programs in mathematics and science education for secondary teachers in Aurora, Illinois high-needs schools. Seventy-five K–12 teachers in mathematics and science, representing six high-need school districts, completed graduate degrees. Research-based methods were used to seamlessly deliver content alongside teaching methods while emphasizing the pedagogy of the content area. These three-year masters programs were designed as long-term professional development intended to encourage teachers to re-examine their teaching style and train them to teach based on an integrative, problem-solving, research-based approach. A standard class session included review and discussion of relevant research articles, addressing misconceptions about content, group problem solving sessions, presenting and discussing different solutions, exploring challenges that may face students as they learn such topics, and delving into methods to best support vertical alignment across grade levels. A significant amount of class time was devoted to reviewing former lesson plans and using gained knowledge to transform them into more effective lessons that better facilitate student learning of content. Lastly, each teacher participated in an internship where they shadowed a scientist or engineer to learn and design STEM activities to use in their classrooms. (Othman, 2012)

The Science Mathematics and Action Research for Teachers project in Illinois delivered an intensive master's degree program in math and science education for elementary school teachers that focused on mathematics and science (biology, chemistry, geology and physics) content and pedagogical knowledge, national and state learning standards, leadership, mentoring, and communication skills. Courses were taught by STEM faculty from Southern Illinois University Carbondale. The graduate program infused inquiry-based and integrated math and science courses, promoted reflective teaching practices among the teachers through action research, and provided a continuous professional network support to teachers through face-to-face and on-line contact. (Wright, 2012)

### **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.

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 Science and Inquiry Learning in Classrooms (SILC) MSP project in Montana implemented a blended model of professional development that included on-line coursework/discussions, interactive webinars, and instructional coaching. Teachers participated in an orientation workshop, a 1.5-day science inquiry workshop, and four inquiry module webinars. Teachers completed on-line preparation such as National Science Teacher Association (NSTA) packets or equivalent assignments, spending around 10 hours per module. Webinars included lecture, discussion, and inquiry demonstrations. Using website and other resources, teachers prepared, taught, and assessed 3–5 lessons per module. Coaches modeled the lessons, provided resources, and clarified and extended content materials. Coaches, experienced elementary teachers, were key collaborators in designing the inquiry modules. The energy inquiry modules (wind energy, biofuels, solar energy, hydrogen fuel cells) included science content and complementary Native American culture materials. Each module included hands-on inquiry activities carried out by students and facilitated by classroom teachers. Module materials were provided at grade-band levels (K–2, 3–5, 6–8). During two of the modules, classrooms received virtual “live scientist visits” to answer student-generated questions and discuss research/career connections. (Swanson, 2012)

The Collaborative for Math Professional Development Project (CoMPD) in Virginia improved the content, pedagogy, and technology knowledge for grade 4–6 teachers and enabled them to transform instructional practices to improve mathematical learning and develop mathematical thinking in all students utilizing a distance learning approach. Teachers participated in a three-credit graduate course in mathematics content. Videoconferencing was used to enable teachers to participate from multiple locations. Distance learning support during the school year was provided through the Southwest Virginia Regional Technology Consortium (SVRTC). The Moodle content management system was used to facilitate interaction among the participants and instructors. Teachers were able to upload their lessons and presentations in Moodle. After feedback from master teachers and course facilitators, teachers improved their lessons and shared their presentations in the Piedmont Council of Teachers of Mathematics. SVRTC continued to produce videos of teacher reflections and update the project resources with teacher lessons and videos. Through virtual mentoring, on-line discussion of effective practices, and classroom visitations and feedback, teachers received support throughout the project. (Talaiver, 2012)

### **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 Science Plus MSP project in Utah aimed to improve science teaching and learning in partnership classrooms through a sustained professional development experience that took place on the Brigham Young University (BYU) campus, at field locations, and in teachers' classrooms. Two all-day sessions in the spring introduced teachers to the geology and biology content and engaged them in the full science inquiry cycle. Content courses were presented by a geologist and biologist using specific grade level pedagogy and integrated technology pedagogy by instructional technology professors. In the summer, teachers had the option of participating in field excursions at the Great Basin or the Colorado Plateau or in a summer internship at the Bean Life Science Museum on the BYU campus. The final phase took place at BYU and in teachers' classrooms as participants each developed and taught two lessons to their students that utilized newly acquired content knowledge and full science inquiry pedagogy. Teachers were scaffolded through the transferring process of classroom observations, self-analysis, goal setting, and peer and staff feedback. (Call, 2012)

The Flooding the Fields with Problem Based Learning project in Wyoming built upon teacher content knowledge in math and science through a problem-based learning (PBL) platform. All activities were hands-on and minds-on inquiry based. Field work experiences focused on the physical and biological characteristics of water. Teachers worked with probeware to collect data, conducted experiments with invertebrate organisms, and analyzed and disseminated data. Teachers had the opportunity to engage in quantitative reasoning skills development and PBL activities that they could then take back to their classroom. (Forrester, 2012)

## 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 the 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.<sup>18</sup>

As seen in Exhibit 21, more than two-thirds of projects (71 percent) reported using an external evaluator in PP11. Using external evaluators—specialized staff from outside the partnership trained to conduct evaluations—allows projects to independently evaluate their work, and to receive help from these specialists in implementing the most rigorous designs feasible. One-third of projects (33 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, 11 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 2011

Type of Evaluator	Percent of Projects (N= 498)
External evaluator	71%
MSP partnership organization staff	33
Statewide evaluation	11
Other	3
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 PP11. Projects that used a combination of designs were instructed to report on the most rigorous design used in the project. Half of projects (50 percent) reported using an experimental or quasi-experimental design. One 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 (49 percent) 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. Nearly one-third of projects (30 percent) used a matched comparison group design,

<sup>18</sup> Since not all teachers receive professional development each year, teachers are only required to be tested at least once during the life of the project. Additionally, student proficiency is only required to be reported in the periods following intensive professional development of teachers.

which attempts to show causality by demonstrating equivalence between groups at baseline or adjusting for any initial differences between groups, and 19 percent of projects reported using a non-matched comparison group.

The remaining 50 percent of projects reported using a less rigorous design type. Thirty-four percent of projects reported using pre-tests and post-tests to assess the gains of the teachers served by MSP. Ten percent of projects reported using qualitative methods only, and 6 percent of projects reported using a mix of quantitative and qualitative methods.

**Exhibit 22: Types of Evaluation Designs Used by Projects, Performance Period 2011**

Evaluation Design	Percent of Projects (N=497)
Random assignment design (experimental)	1%
Quasi-experimental design	49
<i>Matched comparison groups</i>	30
<i>Non-matched comparison groups</i>	19
One-group design	34
Qualitative / descriptive design	10
Mixed methods	6
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 apply 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 are required to administer pre- and post-tests during the year(s) in which their teachers receive intensive professional development. Projects used the MSP program’s Teacher Content Knowledge macro to determine the number of teachers with statistically significant gains in teacher content knowledge.<sup>19</sup> 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 (68 percent) and in science (42 percent). The next most frequently reported type of assessment for both mathematics (18 percent) and science (37 percent) was locally developed assessments that were not tested for validity, followed by locally developed assessments with evidence of validity and reliability (13 percent of projects for mathematics and 23

<sup>19</sup> 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.

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 2011**

Assessment Type	Percent of Projects		
	Mathematics Content Knowledge (N=290)	Science Content Knowledge (N=211)	Classroom Practices and Beliefs (N=253)
Standardized test	68%	42%	37%
Local test, not valid & reliable	18	37	15
Local test, valid & reliable	13	23	10
Surveys or ratings	5	4	55
Other type of test	10	7	25

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 (55 percent) reported using surveys or ratings by teachers, students, or other MSP participants. Additionally, 37 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* (37 percent of projects), the *Teacher Efficacy Belief Instrument* (15 percent), the *Reformed Teaching Observation Protocol (RTOP)* (14 percent), and the *Surveys of Enacted Curriculum* (13 percent).

**Exhibit 24: Assessments Utilized to Assess Teachers in Classroom Practices and Beliefs, Performance Period 2011**

Classroom Practices and Beliefs Assessment Measure	Percent of Projects Utilizing this Assessment (N=254)
Survey of Teacher Attitudes and Beliefs	37%
Teacher Efficacy Belief Instrument	15
Reformed Teaching Observation Protocol (RTOP)	14
Surveys of Enacted Curriculum (SEC)	13
Inside the Classroom Observation Protocol	7
Other assessment	57

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 *Learning Mathematics for Teaching (LMT)* (38 percent of projects) and *Diagnostic Mathematics Assessments for Middle School Teachers* (19 percent). For measuring content knowledge in science, the two most commonly reported assessments were *Diagnostic Teacher Assessments in Mathematics and Science (DTAMS)* (15 percent) and *MOSART: Misconception Oriented Standards-Based Assessment* (12 percent).

**Exhibit 25: Assessments Utilized to Assess Teachers in Mathematics, Performance Period 2011**

Mathematics Assessment Instrument	Percent of Projects Utilizing this Assessment (N=293)
Learning Mathematics for Teaching (LMT)	38%
Diagnostic Mathematics Assessments for Middle School Teachers	19
State teacher assessment	5
PRAXIS II	2
Knowledge of Algebra for Teaching	1
Other assessment	55

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 2011**

Science Assessment Instrument	Percent of Projects Utilizing this Assessment (N=211)
Diagnostic Teacher Assessments in Mathematics and Science (DTAMS)	15%
MOSART: Misconception Oriented Standards-Based Assessment	12
State teacher assessment	5
Assessing Teacher Learning about Science Teaching (ATLAST):	1
Force Concept Inventory	1
PRAXIS II	<1
Other assessment	73

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 (94 percent) that measured student achievement in *mathematics* reported using standardized tests. However in *science*, just over half of MSP projects (57 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 (50 percent) and/or other types of tests (20 percent) to assess student achievement.

**Exhibit 27: Types of Assessments Utilized to Assess Student Achievement, Performance Period 2011**

Assessment Type	Percent of Projects	
	Mathematics (N=200)	Science (N=170)
Standardized test	94%	57%
Local test, valid & reliable	10	34
Local test, not valid & reliable	7	16
Self-report	2	3
Other type of test	4	17

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 0 percent for both Mathematics and 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 (83 percent) in PP11 used questionnaires or other forms of self-reporting by teachers, and two-thirds of projects engaged in direct classroom observation (69 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. Eighteen percent of projects reported reviewing journals in which participants tracked lesson plans and reflected on classroom practice, 13 percent reported videotaping lessons, and 10 percent each reported conducting interviews or focus groups and lesson plan analysis. Thirteen 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 2011**

Measures	Percent of Projects (N=499)
Questionnaire/Self-report	83%
Classroom observation	69
Journals	18
Videotaping	13
Interviews/Focus groups	10
Lesson plan analysis	10
Blogs	5
Other	13

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.<sup>20</sup> In mathematics, 23,807 teachers reported receiving professional development courses in PP11, and 45 percent of these teachers had assessment data available for the period. In science, 16,042 teachers reported receiving professional development courses in PP11, and 58 percent of these had assessment data available for that period.

<sup>20</sup> 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 2009–2011**

Content Area	Total Number of Teachers Served <sup>1</sup>			Percent of Teachers with Content Assessments (Pre-Post)		
	PP09	PP10	PP11	PP09	PP10	PP11
Mathematics	31,512 <sup>2</sup>	25,344	23,807	42% <sup>2</sup>	53%	45%
Science	23,310	19,562	16,042	47	60	58

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.

<sup>1</sup> Beginning in PP09, individual teachers who received multiple professional development courses may have been counted multiple times.

<sup>2</sup> This number was adjusted from the PP09 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 PP11, 61 percent showed significant gains in mathematics content knowledge and 69 percent showed significant gains in science content knowledge. This represents a slight decline in teacher gains in both math and science over the past two years.<sup>21</sup> As discussed above, 69 percent of projects used standardized tests to assess teacher content knowledge in math, and 42 percent used standardized tests to assess content knowledge in science.

**Exhibit 30: Percent of Teachers with Significant Gains in Content Knowledge, Among Teachers with Pre-Post Content Assessments, Performance Periods 2009–2011**

Content Area	PP09	PP10	PP11
Mathematics	62%	65%	61%
Science	71	74	69

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 1.4 million students in PP11 were taught by teachers who received professional development in mathematics, and over 800,000 students were taught by teachers who received professional development in science. The proportion of students taught by MSP mathematics teachers has been growing relative to the students taught by science teachers.

<sup>21</sup> Given that a different set of teachers are tested each year, it is not surprising that the level of gains does not necessarily display an increasing trend.

**Exhibit 31: Number of Students Served and Percent of Students Assessed, Performance Periods 2009–2011**

Content Area	Total number of students taught by MSP teachers			Percent of students with content assessments		
	PP09	PP10	PP11	PP09	PP10	PP11
Mathematics	1,476,835	1,280,438	1,407,724	51%	64%	50%
Science	1,157,168	903,788	814,751	33	39	29

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 50 percent of students in mathematics and for 29 percent of students in science, which both reflect decreases from the previous year (see Exhibit 31). The proportion of students being assessed at the proficient level or above remained relatively stable over the past three years. In PP11, in mathematics, 64 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.<sup>22</sup> The results from the past three years represent an increase in students scoring at the proficient level compared to 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 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 2009–2011**

Content Area	Proficient Level or Above		
	PP09	PP10	PP11
Mathematics	64%	65%	64%
Science	63	67	67

Source: Annual Performance Report items VIII.B. 2, 3, 4, 6, 7, 8  
 In PP09 the non-response rates were 8 percent in mathematics and 11 percent in science; in PP10 the non-response rates were 8 percent in mathematics and 7 percent in science; and in PP11 the non-response rates were 10 percent in mathematics and science.

<sup>22</sup> Numbers were aggregated across all grade levels and schools.

## Chapter 5: Highlights from MSP Projects with Rigorous Designs

Among the 157 MSP projects that reported that PP11 was their final year, 17 projects used rigorous evaluation designs to demonstrate the impact of their programs on teachers and students. In this chapter, we provide highlights from these 17 projects. Appendix A outlines the review process for selecting this set of projects, according to the criteria of rigorous evaluation design. Appendix B describes the criteria used to determine rigor of design. By reviewing the findings from these rigorous evaluations, we can gain insight into what aspects of professional development are associated with improvements in teacher content knowledge, student achievement, and/or teacher practices.

Although most of these passing projects evaluated multiple outcomes within their final year reports, only those aspects of their research that were conducted in a rigorous manner and pertain to the potential *impact* of MSP programs on teacher content knowledge, teacher practices, or student achievement are included in this chapter.

For each project with an evaluation that met 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 upon information included in the projects' evaluation reports and their PP11 APRs. Exhibit 33 provides information about each passing MSP project. Below we provide a brief overview of key findings.

### Key Findings

#### *School Level of Participants Trained*

- The majority of projects (13) were designed for both elementary and middle school teachers. One project was designed for elementary school teachers exclusively, two projects were designed for middle school teachers exclusively, and one project was designed for high school teachers.
- Two projects worked additionally with principals and school administrators.

#### *Professional Development Initiatives*

- One project provided professional development in both math and science, 11 projects focused on math exclusively, and 5 focused on science exclusively.
- The majority of projects (15) provided at least one summer component ( a workshop or institute); 1 of these projects provided an intensive summer institute of at least 60 hours.
- Fourteen projects provided follow-up activities in the form of weekend sessions, individual coaching, on-line training, workshops, staff development, or other training; 1 project provided follow-up classroom visits from university faculty during the school year.
- Five projects incorporated the Intel Math Curriculum, including a Math Learning Community component for participants. One project offered a conference component, and two projects offered credit toward a Master's degree.
- Four projects encouraged the development of leadership skills and "teacher leaders"; two projects used current teacher leaders to facilitate the professional development.

- One project aimed to close the racial and socioeconomic achievement gap in mathematics; one focused on mathematics special education instruction.

### ***Research Designs Used***

- All projects successfully employed quasi-experimental study designs (QEDs); no projects used a randomized control trial (RCT).
- Among the 17 projects that conducted successful quasi-experimental evaluations, 7 projects successfully studied their program's impacts on teacher content knowledge, 2 projects successfully studied impacts on classroom practices, and 11 projects successfully studied impacts on student achievement.
- Six of the evaluations found positive impacts of the MSP on teacher content knowledge, two found positive impacts on classroom practice, and three found positive impacts on student achievement.

### ***Assessments Used***

- Among the seven projects that successfully studied their program's impacts on *teacher content knowledge*, three were evaluated using the Learning Mathematics for Teaching (LMT) assessment, two were evaluated using the Intel Math Content test, one was evaluated using the Assessing Teacher Learning about Science Teaching (ATLAST) Force & Motion test, and one used a test designed specifically for the evaluation.
- Among the two projects with positive findings in *classroom practices*, one project used the Reformed Teaching Observation Protocol (RTOP) to assess classroom practices, and the other project used the Survey of Enacted Curriculum (SEC).
- Among the 11 projects that successfully studied their program's impacts on *student achievement*, 10 used state or district standardized test questions to measure achievement, and 1 used the Measures of Academic Progress (MAP).

**Exhibit 33: MSP Projects with Rigorous Evaluation Designs**

MSP Project	State	Participants	Content Area	Professional Development	Design of Passing Evaluation(s)	Evaluations with Positive Findings
<i>Algebra II: Gateway to a Smart Future</i>	AR	19 high school teachers	Math	30-hour summer workshop for 3 years; 5 follow-up trainings during the school year; classroom visits from university math faculty during the school year	QED	None
<i>Science Academy for Middle School Teachers (SAMST)</i>	AR	29 5th–7th grade science teachers	Science	2 weeks of teaching in summer academy; 1 follow-up session in the fall; 1 follow-up session in the summer	QED	Teacher content knowledge
<i>University of Arkansas Engineering and Science Partnership (UA-ESP)</i>	AR	41 teachers from grades 6 and 7	Science	6-day summer workshop; 4 mini-workshops and follow-up classroom activities during school year	QED	None
<i>Kingman Intel Mathematics (KIM)</i>	AZ	38 elementary and middle school teachers	Math	40-hour summer session; 48 hours of weekend follow-up; 8 hours of learning community meetings; 16 hours of on-line training	QED	Teacher content knowledge
<i>Increasing Math Performance, Achievement, and Content Knowledge for Teachers (IMPACT)</i>	AZ	29 elementary school teachers, 9 middle school teachers	Math	6-day summer session; 4 follow-up weekend sessions	QED	Teacher content knowledge
<i>Tucson Unified School District (TUSD) K–8 Intel Math Project</i>	AZ	65 K–8 teachers, 10 principals	Math	2 summer academies (totaling 8 days); 6 days of follow-up during school year, including learning community meetings	QED	None
<i>Chandler Intel Mathematics Academy (CIMA)</i>	AZ	59 teachers from grades 1–6	Math	4 monthly winter academies; 20 hours of learning community meetings	QED	Classroom practice, student achievement
<i>Gila Elementary Math Masters (GEMMs II)</i>	AZ	32 elementary school teachers, 13 middle school teachers	Math	80 hours of training over several 2- and 3-day segments; 30 hours of learning community meetings	QED	Teacher content knowledge
<i>Science Model Academy for Reflective Teaching (SMART)</i>	CA	42 teachers from grades 3–8	Science	48-hour intensive summer session, 2 all-day model academies during the school year, and 4 lesson planning days	QED	Teacher content knowledge
<i>Kings Canyon Unified School District (KCUSD) Science Project</i>	CA	38 elementary and middle school teachers	Science	44-hour summer session; 16 hours of training during the school year; 24 hours of Teaching Learning Collaboratives	QED	None

Mathematics and Science Partnerships: Summary of Performance Period 2011 Annual Reports

MSP Project	State	Participants	Content Area	Professional Development	Design of Passing Evaluation(s)	Evaluations with Positive Findings
<i>Success in Understanding Math (SUM)</i>	CA	56 teachers from grades 3–Algebra I, 6 teacher facilitators, 1 district math coach	Math	Summer institute, study lessons, and after-school sessions	QED	None
<i>Expert Teachers x Explicit Math Instruction = Exemplary Student Achievement</i>	CA	35 teachers from grades 3–Algebra I	Math	Two 30-hour sessions; 12 hours of on-site training and individual coaching	QED	Teacher content knowledge
<i>North East Bay Mathematics Collaborative (NEBMC)</i>	CA	100 teachers from grades 3–Algebra I	Math	30-hour summer sessions; monthly follow-up sessions; 24 hours of individual coaching	QED	Student achievement
<i>Stanislaus County Math Partnership</i>	CA	92 teachers from grades 5 and 6	Math	40-hour summer session; 30 hours lesson study; 12 hours of individual coaching during the school year	QED	None
<i>Sprouting STEMS</i>	IL	40 elementary school teachers	Math and Science	2-week summer session; 24 hours staff development during the school year; 1 conference and 1 seminar	QED	Classroom practice
<i>The Vermont Science Initiative (VSI)</i>	VT	169 K–8 teachers	Science	2-week summer courses; 2 weekend courses; opportunity to pursue MA degree and other programs	QED	Student achievement
<i>Alliance for Teaching Mathematics to Special Education Learners</i>	WI	47 teachers from grades 4–9	Math	3-year professional development through seminars, weekly 3-hour sessions, 1 summer course	QED	None
Sources: Performance Period 2011 APRs and Evaluation Reports						

**Algebra II: Gateway to a Smart Future**

**State (APR ID):** Arkansas (AR090417)

**Partners:** 11 Arkansas public high schools and 1 private school, University of Central Arkansas  
Department of Mathematics

**Project Director:** Aimee Evans

**Number of Participants:** 19 mathematics high school teachers who teach or coach algebra II

**Background:**

The goal of Algebra II: Gateway to a Smart Future was to increase high school math teachers' algebra II pedagogical content knowledge with the hopes that the subject would be taught more effectively to ultimately increase student achievement in algebra II. Because the Common Core State Standards will require a broader population of students to master more algebra II skills, new items of importance were given particular attention.

**Description of Professional Development:**

For each of three years, high school algebra II teachers participated in 30 hours of summertime professional development focused on increasing their algebra II content knowledge and pedagogical skill. Throughout the school year teachers participated in five follow-up trainings and university mathematics faculty” visited the teachers’ classes

*These collaborative experiences are invaluable to the university faculty as well. The work makes my math education courses more authentic. To have the chance to try material with students and learn from both failures and successes has made me a more effective university teacher.*

—Future faculty participant

multiple times to teach lessons. The faculty time in the classroom afforded high school students the unique opportunity to develop a relationship with university faculty. The project reported that students found this experience very valuable and that the faculty felt it enhanced their teaching of undergraduate and graduate courses and made them more prepared to work with preservice and inservice teachers in adopting the CCSS.

*I have changed my viewpoint about how math can be taught for better student understanding. My students appreciate being shown "why" something works and especially "how" they can apply it.*

—Future teacher participant

The professional development was planned and implemented by university faculty. The curriculum was developed in reference to teachers’ existing content knowledge and based on CCSS. The overarching questions guiding the professional development centered on assumptions, structure and relationships among expressions, connections between the mathematics being studied and other math topics, and implications of different representations of visual information. Some of the topics on which the professional development focused included interpreting graphs with minimal numerical information, algebraic solutions that produce extraneous answers, trigonometry, statistics and probability, and the conditions under which functions are or are not closed.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

**Student Achievement**

Evaluators compared 504 student participants to 770 comparison students to examine whether there was a difference in algebra knowledge as measured by the state Algebra II ADP test in year 2 of the program. The evaluators found that the comparison group showed significantly higher scores than the participant group.

***Science Academy for Middle School Teachers (SAMST)***

**State (APR ID):** Arkansas (AR090418)

**Partners:** Northcentral Arkansas Education Service Cooperative (NAESC), Arkansas State University faculty from the Science and Education Department and the Mountain Home district

**Project Director:** Gayle Ross

**Number of Participants:** 29 5<sup>th</sup>–7<sup>th</sup> grade science teachers

**Background:** Science Academy for Middle School Teachers uses research-based training and new technology to enhance the science content knowledge of 5<sup>th</sup> to 7<sup>th</sup> grade science teachers from school districts in and around the Northcentral Arkansas Education Service Cooperative (NAESC) in Melbourne, Arkansas. NAESC partnered with Mountain Home as a high-needs district and with Arkansas State University. The content of the professional development was based on needs assessments of teacher knowledge of the 5<sup>th</sup> to 7<sup>th</sup> grade Arkansas Science Frameworks

**Description of Professional Development:** During a two-week summer science academy, science and education faculty members taught middle school teachers about various features of the earth including its structure, building blocks, and changes. Participants visited a cavern to examine cave formation. Participants also studied weather and the bi-directional relationship between Earth and weather, and visited the National Weather Service office. One follow-up session was held in the fall and one in the summer. In addition, there were two days of in-class mentoring for each teacher, at which time the mentors presented model lessons, conducted co-teaching, or observed.

**Description of Evaluation with Rigorous Design:**

The evaluation of *teacher content knowledge* among middle school teachers met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Teacher Content Knowledge***

The evaluators conducted a quasi-experiment to assess whether increases in science knowledge were greater for the 29 teachers who participated in SAMST than for the 19 comparison teachers with similar levels of science knowledge at pre-test who did not participate in the project. Science knowledge was assessed using a 20-item test designed for this evaluation that included questions from several standardized tests (e.g., the National Assessment of Educational Progress, the Third International Math and Science Study). The evaluators reported that the post-test scores of teachers participating in SAMST were significantly higher than those of comparison teachers, after adjusting for pre-test scores.

**University of Arkansas Engineering and Science Partnership (UA-ESP)**

**State (APR ID):** Arkansas (AR090421)

**Partners:** University of Arkansas College of Engineering, Northwest Education Renewal Zone, Springdale Public Schools, eight public school districts, and one private school

**Project Director:** Bryan Hill

**Number of Participants:** 41 6<sup>th</sup> and 7<sup>th</sup> grade science teachers

**Background:** The University of Arkansas Engineering and Science Partnership aimed to increase 6<sup>th</sup> and 7<sup>th</sup> grade students' (including English Language Learners') science achievement and enthusiasm for science by increasing their teachers' content knowledge and science teaching skills. Teachers' confidence in teaching physical science was bolstered by receiving professional development that incorporated hands-on activities drawn from the Arkansas Science Curriculum Framework.

**Description of Professional Development:** 6<sup>th</sup> and 7<sup>th</sup> grade science teachers participated in a six-day summer workshop, four smaller workshops during the school year, and additional follow-up classroom activities. The professional development was prepared and administered by faculty and staff from the College of Engineering, the College of Education, and professors from Biological Science and Exercise Science. The faculty members were selected to participate in the program because of their content knowledge, dedication to K–12 education, and ability to make technical information accessible to young students. The professional development focused on the physical sciences but also covered content in the life sciences, another area of weakness for students on standardized tests.

**Description of Evaluation with Rigorous Design:**

The evaluation of *student achievement* in 7<sup>th</sup> grade science met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student Achievement***

The evaluators conducted a quasi-experiment to assess whether increases in students' science knowledge were greater among 10 schools that participated in UA-ESP than among 10 matched comparison schools with similar levels of science knowledge at pre-test that did not participate in the project. Science knowledge was assessed using the Arkansas Benchmark Grade 7 Science scaled scores. The evaluators reported that in 2012 the post-test scores among schools participating in the project were higher than post-test scores among comparison schools, with the difference approaching statistical significance. Schools participating in UA-ESP also scored higher than comparison schools on the 2012 administration of the Iowa Test of Basic Skills Grade 7 Science Test, but the difference was not statistically significant.

**Kingman Intel Mathematics (KIM)**

**State (APR ID):** Arizona (AZ101202)

**Partners:** Kingman Unified School District #20 and Northern Arizona University (NAU) Department of Mathematics and Statistics

**Project Director:** Jenny Taylor

**Number of Participants:** 38 teachers from seven elementary schools and two middle schools

**Background:**

The goals of the KIM project were to increase teachers' mathematical content knowledge and conceptual understanding of state and national standards, improve the practice of standards-based instructional applications, improve student knowledge and achievement in mathematics, and sustain the project through site-based learning communities. Recruitment was a challenge in this rural county, so the project pursued multiple strategies, including: a district-wide email, visits to each building by the instructional coach, and stipends offered for completing the professional development.

**Description of Professional Development:**

The KIM project's professional development involved a 40-hour summer institute and 48 hours of weekend follow-up with the Intel Math curriculum, 8 hours of Math Learning Community (MLC) meetings, and 16 hours of on-line training through Ottawa University. Participants used the on-line and MLC sessions to explore topics supplemental to Intel Math, including the Common Core State Standards, Curriculum Topic Study (CTS), Formative Content Probes, and the Arizona state standards, to create guides and lesson plans for implementation.

The KIM project was so valued by both partners that NAU and KUSD received a grant for further professional development under the Improving Teacher Quality program. The project also worked with school administrators to create time for monthly MLC meetings to continue within the school day, and the current participants plan to serve as facilitators.

*KIM has helped me look at math differently. It is not just rules and recipes on how to do a certain type of problem...I see it as a language, something to talk about, discuss, and figure out together.*

—KIM participant

**Description of Evaluations with Rigorous Designs:**

The evaluation of *teacher content knowledge* among elementary school teachers met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether 30 elementary school teachers participating in KIM showed greater mathematics content knowledge than a matched comparison group of 25 who did not participate in KIM. The two groups were matched on demographic variables, pre-test scores, and initial classroom observation scores. Teacher content knowledge was assessed via the Learning Mathematics for Teaching elementary assessment. The evaluators reported that participant teachers scored significantly higher than comparison teachers after adjusting for pre-test scores.

**Increasing Math Performance, Achievement, and Content Knowledge for Teachers (IMPACT)**

**State (APR ID):** Arizona (AZ101203)

**Partners:** Tempe Elementary School District #3 and Central Arizona College

**Project Director:** Beth Jensen

**Number of Participants:** 29 elementary school teachers and 9 middle school teachers from 11 public schools and 1 private school

**Background:**

The goal of the IMPACT project was to increase student math achievement by providing professional development in both content knowledge and pedagogy. Teachers participated in the Intel Math Program (IMP) content-based professional development and mathematical learning community (MLC) sessions.

**Description of Professional Development:**

A mathematics content instructor and a mathematics educator teamed to provide a six-day summer institute and four follow-up weekend sessions of the Intel Math Program. The professional development sessions covered the following topics: addition, subtraction, multiplication, division, operations of rational numbers, place value, linear relations, functions, and a capstone project. Each session was followed by homework assignments, on-line reflections, and an MLC meeting. During the MLC meetings, participants examined student work and instructional strategies and engaged in mental math problems. Participating teachers (as well as the control group teachers) received stipends for their participation in the project.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *teacher content knowledge* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether 29 elementary school teachers participating in the IMPACT program showed greater math content knowledge than a matched comparison group of 31 teachers who did not participate in IMPACT. Teacher content knowledge was assessed via the Learning Mathematics for Teaching elementary assessment. The evaluators reported that, after adjusting for baseline differences, the IMPACT teachers performed significantly better than the comparison group on the post-test.

**Tucson Unified School District (TUSD) K–8 Intel Math Project**

**State (APR ID):** Arizona (AZ101204)

**Partners:** Tucson Unified School District (TUSD), the University of Arizona (UA)’s Department of Mathematics and the Institute for Mathematics in Education

**Project Director:** Judith Rogers

**Number of Participants:** 65 K–8 teachers and 10 principals from 9 TUSD sites and 1 private school

**Background:**

The project combined elements of the Intel Math curriculum with the University of Massachusetts’ Mathematical Learning Communities (MLC) curricula. Sites were required to participate in teams that included multiple teachers and either an administrator or a mathematics coach. The team structure was intended to help teachers understand the impact of their grade level in the overall progression toward content proficiency at their site, as well as establish a school-wide culture of mathematical thinking.

**Description of Professional Development:**

Teachers and principals participated in a total of 104 hours of professional development through two summer academies and six days of school year follow-up. A UA mathematician and a UA educator partnered with K–5 mathematics specialists from TUSD to deliver 80 hours of the Intel Math curriculum and 24 hours of the MLC curriculum. At the conclusion of the professional development, participating teachers planned and facilitated school-wide MLC sessions with their non-participating colleagues.

*We have a PD room now that we didn’t have before that lists all of our data from the different benchmarks and standardized tests that we take. We have the data on display along with an area devoted to math in which we are displaying the “TUSD Math Star” that indicates the different areas that we need to be focusing on.*

*—Principal*

**Description of Evaluations with Rigorous Designs:**

Evaluations of *teacher content knowledge* and *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of these evaluations are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether Intel Math teacher participants showed greater content knowledge than a matched comparison group of teachers who did not participate in Intel Math. Teacher content knowledge was assessed via the Learning Mathematics for Teaching (LMT) assessment. The evaluators reported that the 42 Intel Math participants had greater gains on LMT test on the subscales of Numbers and Algebra, and in total mean scores, than the 30 comparison group teachers. However, there were no statistically significant differences between participant and comparison group gain scores on any subscale (Numbers, Algebra, Geometry) or the total scores.

***Student Achievement***

Evaluators used a quasi-experimental design to assess whether the 4<sup>th</sup> grade and 5<sup>th</sup> grade students of participating Intel Math teachers outperformed those of comparison teachers on the Arizona Instrument to Measure Standards (AIMS) Math test gains. The evaluators reported that when both grades were combined, the gains of the students of the control teachers were greater than the gains of the students of the participating teachers on the AIMS Math test. However, the difference was not statistically significant.

**Chandler Intel Mathematics Academy (CIMA)**

**State (APR ID):** Arizona (AZ110901)

**Partners:** Chandler Unified School District, Central Arizona College, and Arizona State University

**Project Director:** Melissa Hosten

**Number of Participants:** 59 teachers in grades 1–6, from nine CUSD elementary schools

**Background:**

The CIMA project's main goals were to establish sustainable Mathematics Learning Communities (MLCs) at each school site, as well as improve teachers' algebraic habits of mind, use of multiple representations, and use of the Standards for Mathematical Practice. Lastly, the project strove to increase teacher analysis of student work to drive and differentiate instruction. To maintain high retention rates, CIMA required teachers to participate in a school-wide model, fostering an interdependent model. CIMA also instituted a signed agreement in which both teachers and principals committed to clearly explained responsibilities, and principals were encouraged to attend trainings to support their staff.

**Description of Professional Development:**

Teachers took part in four monthly winter academies, each exploring a particular area of mathematics content. All professional development techniques were drawn from the Intel Math curriculum. Teachers studied multiplication, division, fractions, place value, linear function, and a capstone pedagogical session. After CIMA, three participating teachers chose to take the Middle Grades AEPA exam to add Middle Grades Mathematics to their certificates, and all passed; the math educator from CUSD also chose to become credentialed for the Intel Math Program.

Teachers also participated in 20 hours of MLC meetings, during which they examined student work and reflected on practice. After CIMA, three sites changed their team meetings to incorporate planning, sequencing, and lesson resource development similar to the MLC structure.

**Description of Evaluations with Rigorous Designs:**

The evaluations of *classroom practice* and 4<sup>th</sup> grade *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The designs and findings of these evaluations are described below.

***Classroom practice***

Evaluators used a quasi-experimental design to assess whether 57 CIMA 2012 teacher participants improved their classroom practice more than a matched comparison group of 58 teachers who did not participate in CIMA 2012. Classroom practice was measured by the Reformed Teaching Observational Protocol (RTOP). The evaluators reported that the CIMA 2012 participant teachers significantly outperformed the control group on RTOP post-test, after controlling the RTOP pre-test score.

***Student achievement***

Evaluators used a quasi-experimental design to assess whether the 4<sup>th</sup> grade students of participating teachers outperformed students of comparison teachers on the Arizona Instrument to Measure Standards (AIMS) Math test scores. The evaluators reported that the 150 students of participating teachers showed significantly higher AIMS scores than the 181 control group students, after controlling for baseline scores and special education and ELL status.

**Gila Elementary Math Masters (GEMMs II)**

**State (APR ID):** Arizona (AZ110903)

**Partners:** The University of Arizona, 5 public schools, 2 tribal schools, and 1 charter school

**Project Director:** Linda O'Dell

**Number of Participants:** 32 elementary and 13 middle school teachers within Gila County

**Background:**

GEMMs II builds on the work of a previous GEMMs project conducted in FY 2010–2011. The GEMMs curriculum supports teachers in building fluency with problem solving, creative critical thinking, and collaboration. Not only did the successes and lessons learned guide the professional development provided during this phase, but teacher leaders trained within previous cohorts served as peer leaders for the most recent cohort.

**Description of Professional Development:**

The GEMMs II program provided K–8 teachers with professional development training in the Intel Math Program (IMP) as well as participation in Mathematics Learning Community (MLC) activities. Two IMP-certified math content and two math education instructors from the University of Arizona delivered 80 hours of IMP content training over multiple three-day segments. IMP's curriculum supports teacher conceptual understanding of math through problem-solving, critical thinking, and collaboration. Teachers in grades K–3 who needed additional time to learn the advanced mathematics content received coaches. After each session, participants completed homework assignments and reflections using an on-line tool. In addition, participants took part in 30 hours of MLC meetings designed to help teachers reinforce, consolidate, and implement advanced content in the classroom. MLCs engaged teachers in group activities, reviewing student work, and discussing curricular and instructional strategies.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *teacher content knowledge* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether 32 GEMMs II teacher participants showed greater mathematics content knowledge than 34 matched comparison groups teachers who did not participate in GEMMs II. Teacher content knowledge was assessed via the Intel Math Content test. The evaluators reported that after adjusting for baseline differences, GEMMs II teachers performed significantly better than the comparison group at the post-test.

**Science Model Academy for Reflective Teaching (SMART)**

**State (APR ID):** California (CA090149)

**Partners:** Shasta County Office of Education, Chico State University, Shasta College, and 17 schools from 8 school districts

**Project Director:** David Ewart

**Number of Participants:** 42 science teachers from (or “of”) grades 3–8

**Background:**

The SMART project focuses on the California state standards for grades 3–8 in earth, life, and physical science. The project draws on a model which was originally developed at CSU Chico to help pre-service teachers improve their pedagogical effectiveness through laboratory-based lesson study.

**Description of Professional Development:**

Teachers participate in a 48-hour summer session as well as follow-up sessions throughout the year. The program’s core element was the Hands-On Laboratory (HOL). In each session, a lesson study team would design six hands-on stations related to one larger science concept. Students rotated through and completed HOL booklets, while teachers provided guidance and reviewed the HOL booklets for formative assessment. Meanwhile, teachers’ lesson study partners observed, using prompts to foster their own pedagogical reflections. Students also had the opportunity to become community science interns in the HOL, assisting with demonstrations and serving as science docents.

*Relationships that I've built during this grant with our area teachers have established multiple opportunities for me each year to go to K–8 classrooms and help teachers with curriculum, or help with presentation of concepts. The teachers have a lot of great ideas on what works in their classrooms and we can directly apply their knowledge base to what we do here in the hands-on lab at Shasta College. So not only are we providing them information, but they have provided us a great deal of information on the way that their students learn. I have used a number of items that we have developed for the SMART Model Academy in my own college courses for teaching the same concepts to the college students, largely because many college students learn just like the K–8 students.*

– SMART Professor

**Description of Evaluations with Rigorous Designs:**

The evaluations of *teacher content knowledge* and *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of these evaluations are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether 34 SMART science teacher participants showed greater content knowledge than 37 matched comparison teachers who did not participate in SMART science, in the third year of the program. Teacher content knowledge was assessed via the Assessing Teacher Learning about Science Teaching (ATLAST) Force & Motion test. The evaluators reported that on average, treatment group teachers showed significant gains from the pre-test to the post-test, whereas comparison group teachers did not.

***Student achievement***

Evaluators used a quasi-experimental design to assess whether the 8<sup>th</sup> grade students of participating teachers outperformed those of comparison teachers on the Shasta County Science Assessment (SCSA). The evaluators reported that the 94 treatment group students outperformed the 243 comparison group students as measured by the percent change from pre-test to post-test on the SCSA assessment.

**Kings Canyon Unified School District (KCUSD) Science Project**

**State (APR ID):** California (CA090153)

**Partners:** Kings Canyon Unified School District (KCUSD), Sanger Unified School District, California State University at Fresno, and WestEd K–12 Alliance

**Project Director:** Janie Chiasson

**Number of Participants:** 38 elementary school and middle school teachers from two rural districts

**Background:**

This project aims to increase the science achievement of students in grades 3 through 8 in two rural school districts by providing professional development to improve teachers’ science content knowledge and pedagogical skill.

**Description of Professional Development:**

Teachers participated in 44 hours of a Summer Science Program co-led by an IHE professor and a pedagogy expert. The Institute covered life, earth, and physical sciences, and incorporated notebook and field experiences. During the school year, teachers took part in 16 hours of rigorous content and pedagogy training. Additionally, 24 hours were spent in Teaching Learning Collaboratives, a kind of lesson study that emphasized teamwork in lesson planning, utilization of the 5E learning sequence, and professional relationship-building among science teachers. Four additional non-participating teachers were trained through a 10-day professional development program to become teacher leaders, and eight undergraduate science education students assisted and observed participating teachers.

As an outgrowth of this project, participating schools are now incorporating common planning time into teachers’ schedules to promote collaboration among science teachers.

*When I started, I thought I had to stick to what the textbooks had for lessons. Now, I am confident to design lessons and activities that are better and to use the text as a resource rather than the center of the lesson. You have me “permission” to do a better job and focus on the kids!*

—KSUCD participant

**Description of Evaluations with Rigorous Designs:**

The evaluation of 5<sup>th</sup> grade *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student achievement***

Evaluators used a quasi-experimental design to assess whether 48 5<sup>th</sup> grade students of participating teachers outperformed 138 students of comparison teachers from the same schools. Students’ science achievement was measured by district performance assessment scores. The evaluators reported no statistically significant difference between the two groups of students after controlling for pre-test scores.

**Success in Understanding Math (SUM)**

**State (APR ID):** California (CA090156)

**Partners:** Coachella Valley Unified School District, CSU San Bernardino, College of the Desert Community College, WestEd K–12 Alliance

**Project Director:** David Budai

**Number of Participants:** 56 teachers in grades 3 through algebra 1, six teacher facilitators, and one district math coach

**Background:**

Guided by the experience from previous professional development projects, these partners set out to increase teacher content knowledge and pedagogical ability, promote student math achievement, and foster leadership skills to build district capacity and to promote the sustainability of the program.

**Description of Professional Development:**

Participants were provided with between 94 and 120 hours of professional development, divided among a Summer Content Institute, Teacher Learning Community lesson study lessons, and after-school formative assessment focused sessions. The Summer Content institute, which was taught by at least one IHE faculty member and one master teacher, covered a range of mathematical topics and teaching strategies and included techniques for teaching ELLs. The teacher facilitators and the district math coach also took part in a 9-day institute to refine leadership and coaching skills.

**Description of Evaluations with Rigorous Designs:**

The evaluation of 3<sup>rd</sup> grade *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student Achievement***

Evaluators used a quasi-experimental design to assess whether participant group students outperformed comparison group students on math achievement assessed by the Blueprint Assessment (based on released CST items) for SUM. The evaluators used an analysis of variance procedure in which the percent correct on pre-test served as a covariate to test the hypothesis. They found that, for the 3<sup>rd</sup> grade, the 276 comparison group students' mean gain scores were larger than those of the 240 students in the participants' group, and this finding was statistically significant.

**Expert Teachers x Explicit Math Instruction = Exemplary Student Achievement**

**State (APR ID):** California (CA090157)

**Partners:** Central Unified School District, CSU Fresno, and Fresno Pacific University

**Project Director:** Julie Smith

**Number of Participants:** 35 math teachers in grades 3 through algebra I

**Background:**

The goal of the project was to develop teacher leaders who initiate and maintain institutional change in math teaching to positively impact students' mathematical understanding, learning, and achievement, including the completion of algebra I. Mathematics and math education faculty from both universities designed and conducted the professional development; grades 3–6 by Fresno Pacific University, and grades 7–12 by CSU Fresno.

**Description of Professional Development:**

Teachers participated in two 30-hour institutes, one in summer and one in winter. Each institute was followed by 12 hours of on-site professional development in addition to individual coaching in cognitively guided instruction (CGI) during follow-up sessions, grade- and course-level specific teams conducted lesson study. Lesson study units focused on sense-making, problem solving, inquiry-based teaching, incorporating technology such as Sketchpad and GeoGebra, engagement strategies, use of direct instruction and CGI, and checking for understanding.

As a result of this project, participants moved on to become district instructional trainers and coaches. The district implemented professional learning communities and built-in common planning time districtwide to improve collaborative mathematics. The partner IHEs revised their teacher preparation coursework and created two new math courses, and five faculty members collaborated to co-author a textbook on higher math preparation for elementary teachers.

*Students in my class want to do math in my class more. I purposely look to present problems that have more than one solution so that the students can talk about how they see a problem and the plan of attack in solving the problem.*

*As I progressed through this Lesson Study experience, I found myself challenged and looking at problems from different points of view. I was enjoying myself. Then when I started to apply how I was being challenged, my students began enjoying math more.*

*—Program participants*

**Description of Evaluations with Rigorous Designs:**

The evaluation of *teacher content knowledge* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Teacher Content Knowledge***

Evaluators used a quasi-experimental design to assess whether 14 participating elementary teachers outperformed 11 control group teachers on the Learning Mathematics for Teaching elementary Numbers, Concepts, and Operations assessment. The evaluators reported that the average gain of participating elementary teachers was significantly greater than that of the control group teachers.

**North East Bay Mathematics Collaborative (NEBMC)**

**State (APR ID):** California (CA090159)

**Partners:** The Mathematics Coaching Consortium (MCC), California State University East Bay (CSUEB), and six school districts within Contra Costa County.

**Project Director:** Christie Daniels

**Number of Participants:** 100 mathematics teachers from grades 3 through Algebra I

**Background:**

The MCC evolved from a partnership between the Alameda County Office of Education’s Math Development Center, and the Alameda County Collaborative for Learning and Instruction in Mathematics. The NEBMC drew on this prior work to provide a vehicle for several non-unified, but related, districts in Contra Costa County to enhance and align their mathematics collaboration. The project’s goals were to improve teacher content and pedagogical knowledge, prepare math teachers to provide standards-based instruction, and eliminate the achievement gap in mathematics for African-American, Hispanic, and socioeconomically disadvantaged students.

**Description of Professional Development:**

IHE mathematics faculty and NEBMC mathematics coaches delivered a 30-hour summer institute including both content and pedagogy sessions. Cohorts received monthly site-based follow-up sessions and 24 hours of individual coaching. In addition, participants collaboratively designed pacing guides, local assessments, and lesson plans. Since the partner districts feed into one high school, unifying these materials was important for the transition from middle to high school. Participants also analyzed formative data to develop “instructional mitigations,” or strategic interventions to improve student achievement. The partnership created an administrator induction and training process, incorporating an overview of the model and what to look for in classroom instruction.

Participating districts allowed coaches to exclusively support teachers above other tasks and paid teachers to attend NEBMC sessions and events, including non-grant teachers. Each district also provided a technical support staff member to create a data management system for teachers to create instructional mitigations. They have created common standards for increased accuracy in algebra I placement and share website access to all materials developed by the partnership. The IHE is creating a blended bachelors’ degree and teaching credential program based on NEBMC work.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student Achievement***

Evaluators used a quasi-experimental design to assess whether students of NEBMC teachers outperformed students of the comparison teachers on the mathematics California Standards Test (CST) in 2010. The two groups were matched on average 2009 Mathematics CST scaled score. The evaluators reported that in 2010, the treatment group’s average CST score was significantly higher than that of the comparison group.

**Stanislaus County Math Partnership State (APR ID): California (CA100175)**

**Partners:** Ceres Unified School District (CUSD), California State University (CSU) Stanislaus, and the Stanislaus County Office of Education

**Project Director:** Jan Wood

**Number of Participants:** 92 5<sup>th</sup> and 6<sup>th</sup> grade math teachers

**Background:**

The CUSD project convened a leadership team consisting of 12 individuals who contributed to the development and sustainability of the partnership. The leadership team surveyed participating teachers to identify local needs. Based on the survey, they created professional development activities to target algebra and rational numbers. The professional development activities focused on training in content knowledge, pedagogical knowledge of mathematical discourse and multiple representations, the use of student assessment data to guide instruction, lesson study, and instructional coaching. A project coordinator, five math coaches, one local evaluator, and three IHE professors were involved in the professional development delivery.

*I love that I'm able to work with a team of professional individuals that bring many different facets to a lesson. I now look at lessons more insightfully. I'm willing to try more things. My planning is more in depth and I recognize even more the importance of I do/ we do/ you do and working with an objective.*

—Program participant

**Description of Professional Development:**

Teachers took part in a 40-hour summer institute presented by the IHE professors and math coaches. Summer intensive training emphasized the development of student mathematical discourse and the growth mindset theory by Carol Dweck. In addition, groups followed two formal lesson study sequences for a total of 30 hours, focused either on algebra or on rational numbers. During the school year, teachers received at least 12 hours of one-on-one coaching to ensure that the training transferred to classroom practice.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student achievement***

Evaluators used a quasi-experimental design to assess whether 905 students of participating teachers outperformed 510 students of comparison teachers on the 5<sup>th</sup> grade California Standards Test—Mathematics Cluster 2, which measures mathematics content knowledge in the areas of algebra and functions. The two groups were equivalent on the pre-test score measured in grade 4. The evaluators reported that both groups showed lower scores on post-tests compared to pre-test and there was no significant difference between the two groups on the lower scores.

### **Sprouting STEMS**

**State (APR ID):** Illinois (IL111007)

**Partners:** St. Clair Country Regional Office of Education, Lindenwood University Belleville, and high needs school districts

**Project Director:** Gloria Oggero

**Number of Participants:** 40 elementary school teachers of math, science, and special education

#### **Background:**

Due to a pattern of low performance in the schools in the area, the goal of Sprouting STEMS was to increase performance on state standardized tests by providing professional development that increased teachers' science and math content knowledge, use of technology in the classroom, use of effective teaching strategies (like inquiry-based learning), and knowledge of reading strategies for math and science. The project also exposed teachers to experts in their field of study and offered teachers the opportunity to receive graduate credit in content areas.

#### **Description of Professional Development:**

Teachers participated in a summer institute that involved a week of field study and a week of classroom-based content knowledge and pedagogy development. Teachers conducted supported action research. They attended four six-hour staff development sessions during the school year, the National Council of Teachers of Mathematics conference, and a full day seminar at Southern Illinois University Edwardsville. After the program's completion, over a third of participants went on to pursue a master's degree using credits from Sprouting STEM, and a website with lesson plans and helpful links continues to exist.

*I feel as though I have become a better teacher in ALL subjects due to this project. Many teachers in my district ask for my help (ideas, resources, etc.) with regards to teaching math and science. I will continue to use my resources in the years to come and hope to continue learning and becoming better in STEM teaching.*

— Sprouting STEMS participant

#### **Description of Evaluation with Rigorous Designs:**

An evaluation of one aspect of *classroom practice* met the rigorous criteria used to determine whether an evaluation was conducted successfully.

##### *Classroom practice*

The evaluator used a non-matched comparison group design to assess whether 40 teachers who participated in Sprouting STEMS showed greater change in classroom practices than 41 comparison teachers who did not participate in Sprouting STEMS from similar schools and grade levels. Instructional practices in math and science were measured using composites created from survey items from the *Survey of Enacted Curriculum (SEC)*. The composite measuring teacher preparedness met MSP criteria.

The evaluator reported that the treatment teachers demonstrated a positive and statistically significant gain in their preparedness scores from the pre-test to the post-test on average, while the comparison teachers did not. Additionally, treatment teachers had statistically significant higher average post-test scores than comparison teachers.

**The Vermont Science Initiative (VSI)**

**State (APR ID):** Vermont (VT090712)

**Partners:** Johnson State College, eight other Vermont IHEs, 10 school districts many of which are high-need, and other education or evaluation agencies

**Project Director:** Elizabeth Dolci

**Number of Participants:** 52 K–8 teachers from 23 different districts

**Background:**

The Vermont Science Initiative utilizes a statewide system of support that trains science educators in science content, learning and assessment and utilizes teacher leaders, who administer professional development in their schools, to improve science teaching. The ultimate goal of this program is to improve the science achievement of all Vermont students.

**Description of Professional Development:**

As part of the VSI program, participants can receive a master’s degree in science education for K–8 teachers; take part in the Leadership Academy program, which requires fewer credit hours than the master’s degree; or take coursework in science pedagogy and science content taught by IHE science and education faculty. Courses focus on scientific inquiry, learning communities, and incorporating laboratory experiences. Generally, courses take two weeks in the summer and two weekends. The total number of professional development hours varied from 225 to 30 hours, depending on the participants’ track in the VSI program. Some participants complete a science research independent study project under the mentorship of an IHE science faculty member or other action research.

Those who participate in the master’s degree program become lead teachers in their schools. The VSI program secured local funding that supported course offerings similar to those offered through MSP funding.

**Description of Evaluation with Rigorous Design:**

The evaluation of *student achievement* in 7<sup>th</sup> and 8<sup>th</sup> grade science met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and findings of this evaluation are described below.

***Student Achievement***

The evaluators conducted a quasi-experiment to assess whether increases in science knowledge were greater among 7<sup>th</sup> and 8<sup>th</sup> grade students who were taught by teachers participating in the Vermont Science Initiative (VSI) than among a group of comparison students with similar levels of science knowledge at pre-test who were not taught by VSI teachers. Science knowledge was assessed using a 16-item test designed for this evaluation comprised primarily of questions from multiple state assessments. The evaluators reported that during the 2011–2012 year, VSI-taught students made significantly greater gains from fall to spring than did students in the comparison group who were not taught by VSI teachers.

**Alliance for Teaching Mathematics to Special Education Learners**

**State (APR ID):** Wisconsin (WI110905)

**Partners:** Milwaukee Public Schools (MPS) and the University of Wisconsin-Milwaukee (UWM)

**Project Director:** DeAnn Huinker

**Number of Participants:** 47 general education and special education mathematics in grades 4–9

**Background:**

MPS, the largest school district in Wisconsin, serves approximately 80,000 students across 175 schools. Eighty-three percent of the district’s racially and ethnically diverse students are eligible for free or reduced-price lunch; 10 percent are English Language Learners; and 20 percent are identified with special education needs. Because the proportion of students with special learning needs continues to increase, the Alliance project arose to meet the needs of struggling learners in mathematics with a focus on grades 4–9. Goals of the project included strengthening math content knowledge, providing modification practices for special needs and struggling students, and increasing collaboration in math instruction between general and special education teachers.

**Description of Professional Development:**

The Alliance recruited general education and special education teachers in approximately equal measures. This three-year professional development sequence was offered through the UWM departments of Mathematics, Curriculum and Instruction, and Exceptional Education. Teachers enrolled in concurrent math and education seminars and met weekly for three-hour sessions. While they focused on a content area in the math course (numbers and operations in year 1, geometry and measurement in year 2, and statistics and probability in year 3), the corresponding seminar focused on strategies for differentiation in these areas. Teachers also took one summer course focusing on collaborative curriculum planning.

**Description of Evaluations with Rigorous Designs:**

The evaluation of *student achievement* met the rigorous criteria used to determine whether an evaluation was conducted successfully. The design and finding of this evaluation is described below.

***Student Achievement***

Twenty 2<sup>nd</sup> grade students of Alliance teachers were compared to 16 students of control teachers on the Measures of Academic Progress (MAP) test administered at three time points during the 2011–2012 school year—October, January, and May. Gain scores were calculated by subtracting the October score from the May score. The evaluators reported that there were no significant differences in the MAP gain scores of treated students, compared to control students.

## Chapter 6: 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 2011 (PP11), 499 individual MSP projects were in operation throughout the country. These projects provided professional development to over 43,000 educators who taught over 2.4 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 three thousand faculty members from mathematics, science, engineering, and other departments at IHEs were involved with the MSP projects.

Nearly half of MSP projects (49 percent) in PP11 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 104 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 51 percent of MSP projects in PP11 primarily delivered professional development during the school year, with shorter summer sessions often included. These projects also provided participants with a median of 60 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 (69 percent), followed by locally developed tests (31 percent). The use of locally developed assessments to measure teacher content knowledge in science was more prevalent, with 60 percent of projects using locally developed assessments and only 44 percent using standardized assessments. 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.

Sixty-one percent of participants who were assessed in mathematics showed significant gains in their content knowledge, and 69 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 PP11. In mathematics, 64 percent of

students scored at the proficient level or above. In science, the proportion of students scoring at the proficient level or above was 67 percent.

As they work to determine the impact of their programs, many projects are attempting to implement rigorous evaluation designs. One percent of projects reported using experimental designs, and 49 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 through the Institute for Education Sciences 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 59 projects that completed an experimental or comparison group design and submitted complete data. Seventeen of these projects met the rigorous criteria, which represents over a five-fold increase from PP08. These 17 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 2011 (PP11) annual performance reports (APRs). If projects were missing information needed to determine whether or not the project met the 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 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 set of criteria to assess data quality and rigor of the evaluation.

Each of these stages is described in more detail below.

#### Defining the Set of Project Evaluations

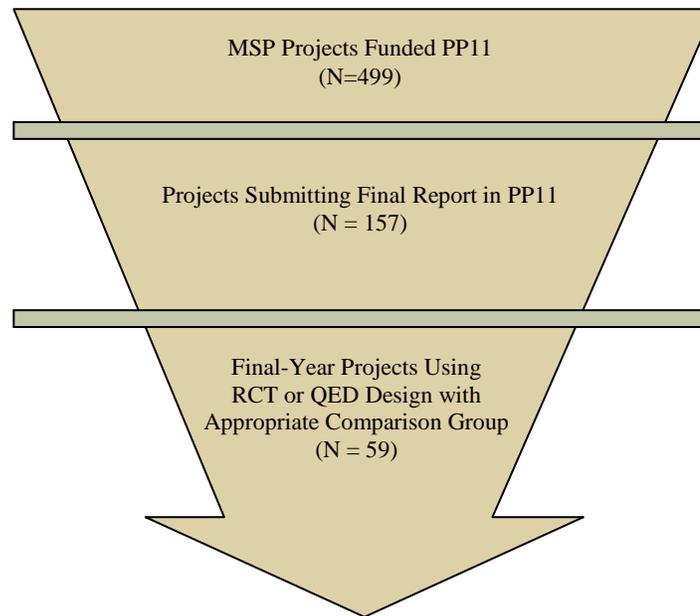
The first step in the review was to identify the projects that were in their final year of funding (Exhibit A.1). Out of the 499 projects funded in PP11, only the 157 projects that reported that PP11 was their final year were reviewed.

Because the purpose of the review was to learn about projects' impact evaluations, we limited our assessment to those that reported using experimental or quasi-experimental designs, both of which are considered to be appropriate for testing the impact of a program or intervention. 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 157 to 75.

We further narrowed the set of projects to 59 by excluding those which on closer review were not in their final year (4 projects) or did not include a comparison group (12 projects). While these 12 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 that 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



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

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Most of the reviewed MSP reports contained separate evaluations of various domains within the same report. We reviewed only the domains with strong theoretical links to MSP’s goals, which included 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* on student achievement. 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*. These criteria were initially developed by Westat as part of the Data Quality Initiative at the Institute for Education Sciences within the U.S. Department of Education and outline the key elements necessary for implementing a rigorous impact design. These criteria have been modified in order to improve the alignment with the review standards used by the What Works Clearinghouse (see Appendix B).<sup>23</sup> The criteria used for assessing the rigor of PP11 MSP evaluations were:

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<sup>23</sup> Beginning in PP10, the 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

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 meet the criteria, evaluations had to satisfy the requirements of each criterion. Of the 59 projects reviewed, 17 projects successfully met all of the criteria.

Of these 17 projects that met the criteria, all were quasi-experimental. Three projects had evaluations that met the criteria in two domains. In total, 11 of the 17 passing projects examined interventions' impacts on student achievement; 7 examined impacts on teacher content knowledge; and 2 examined impacts on classroom practices. In the review that follows, we present the criteria as well as 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.

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 was *baseline equivalence* of the analytic sample. If a study did not provide information to assess 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.

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modification is in addition to changes made for 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. No additional changes were made for PP11.

**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 pre-test sample size and dividing by the pre-test sample size. If an evaluation failed to provide this information and met 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 on-line 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 quasi-experimental 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. There are no pre-intervention differences between groups on variables related to key outcomes that are greater than 5 percent of the pooled standard deviation
2. Minimal pre-intervention differences exist between groups on variables related to key outcomes but those differences are controlled for in analyses.

**Recommendations.**

1. Report key baseline characteristics associated with outcomes for each group, such as pre-test scores and teaching experience. Always include sample sizes when reporting statistics.
2. 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.
3. 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 pre-tested 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 assessments, including standardized state tests and test available on-line 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 5<sup>th</sup> 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 Statistics Reported

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

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

**Screening requirements.** An evaluation passes if one 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. The evaluation provides sufficient information to calculate statistical significance (e.g., reports of mean, sample size, standard deviations/standard error).
- 4.3. Other statistics are provided that indicates 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 both test statistics and significance values. 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. These criteria are shared with all MSP projects and their evaluators and are described during annual regional meetings. Additionally, technical assistance to help projects meet the criteria 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 criteria are relevant to all evaluations, whether as guidance for future designs or for assessing current ones. A summary of the criteria met in PP11 is helpful for understanding which elements of the criteria future projects may need additional guidance on when implementing their evaluations.

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

Finally, as Exhibit A.2 indicates, the number of projects with at least one evaluation meeting all criteria increased four-fold from PP07 to PP09 and the proportion of passing projects continues to rise.

**Exhibit A.2: Final Year Projects that Conducted Rigorous Evaluations and Met MSP Criteria for Rigor, Performance Periods 2007–2011**

Projects	PP07	PP08	PP09	PP10	PP11
Implemented comparison group designs	37	49	65	59	59
Included at least one evaluation that met all criteria	4	3	16	15	17
Percent of projects with at least one passing evaluation	11%	6%	25%	25%	29%

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 and more recently a user-friendly guide to the criteria (Bobronnikov, Sahni, Fernandes, Bozzi, 2013).

## 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)<sup>24</sup>

- 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.

<sup>24</sup> 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](http://ies.ed.gov/ncee/wwc/pdf/wwc_procedures_v2_standards_handbook.pdf)).

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

## B. Baseline Equivalence of Groups

- Met the criterion (quasi-experimental studies).** There were no significant pre-intervention differences, 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 adjusted 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 necessary 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: 2011 State MSP Appropriations

MSP appropriations to states ranged from \$871,257 up to \$20,102,918, with an average of \$3,283,969 and a median of \$2,054,027.

### Exhibit C.1: MSP Appropriations to the States

State	Total Funding Amount	State	Total Funding Amount
AK	\$871,257	MT	\$871,257
AL	\$3,011,829	NC	\$5,322,092
AR	\$2,000,806	ND	\$871,257
AZ	\$4,208,022	NE	\$871,257
CA	\$20,102,918	NH	\$871,257
CO	\$2,046,594	NJ	\$2,933,645
CT	\$1,036,350	NM	\$1,383,863
DC	\$871,257	NV	\$1,207,913
DE	\$871,257	NY	\$9,781,450
FL	\$9,215,675	OH	\$6,148,589
GA	\$6,182,309	OK	\$2,131,366
HI	\$871,257	OR	\$1,756,721
IA	\$1,068,679	PA	\$5,053,589
ID	\$871,257	PR	\$6,621,382
IL	\$6,496,153	RI	\$871,257
IN	\$3,251,776	SC	\$2,757,646
KS	\$1,189,390	SD	\$871,257
KY	\$2,690,719	TN	\$3,702,254
LA	\$2,990,243	TX	\$17,633,540
MA	\$2,061,460	UT	\$1,162,788
MD	\$1,618,199	VA	\$2,733,278
ME	\$871,257	VT	\$871,257
MI	\$5,658,928	WA	\$2,663,206
MN	\$1,829,425	WI	\$2,291,127
MO	\$3,079,319	WV	\$1,007,298
MS	\$2,538,242	WY	\$871,257