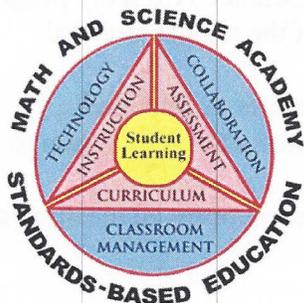


# Math and Science Academy

## 2012-2013 Evaluation

Prepared by Barbara Trujillo, PhD, in collaboration with the MSA team



MSA is a program of the Los Alamos National Laboratory Education & Postdoc Office and the Los Alamos National Laboratory Foundation



## RESEARCH QUESTIONS

Based on the program objectives, the evaluation sought to describe the teacher/principal participants and answer five research questions.

1. Who were the participants in 2012–2013 MSA professional Development activities?

The next three research questions consider the impact of the MSA program in three categories:

2. Teacher Pedagogy and Content Knowledge

- a. To what extent did MSA PD influence participants' beliefs and attitudes for teaching mathematics and science?
- b. To what extent did MSA influence teacher content knowledge in mathematics and science?
- c. To what extent did MSA PD influence participants' reported instructional practices?

3. School Systems Change

- a. To what extent has the MSA program had an impact on systemic reform and capacity building of mathematics/science teaching and learning in the local school district and school unit?

4. Student Learning and Achievement

- a. To what extent did MSA support and influence student learning/achievement in teacher participant classrooms, schools and districts?

The final research question considers all of the program data to determine implications for future planning of MSA professional development.

5. How can the MSA program be refined to better support and enhance teacher professional development, administrative leadership, and student learning and achievement?

## METHODOLOGY

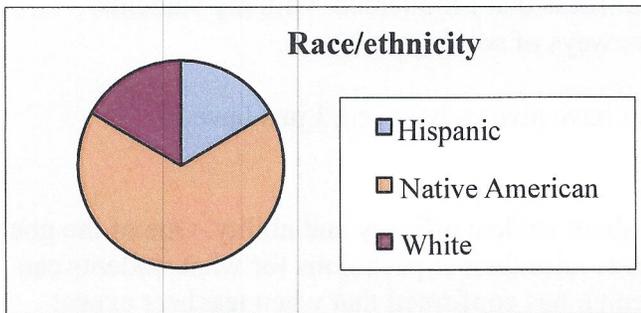
Both quantitative and qualitative measures were used to collect data related to the research questions. Table 1 indicates the data collection plan on page \_\_\_\_ of this report. Quantitative data collection methods included:

- Science Institute pre/post assessment data on science content knowledge for participants and their students
- Ir-Rational Numbers pre/post assessment data on mathematics content knowledge for teaching
- Pre/post LMT assessment of mathematics content knowledge for teaching for Core participants
- Student standards-based assessment scores
- Survey of teacher beliefs and practices

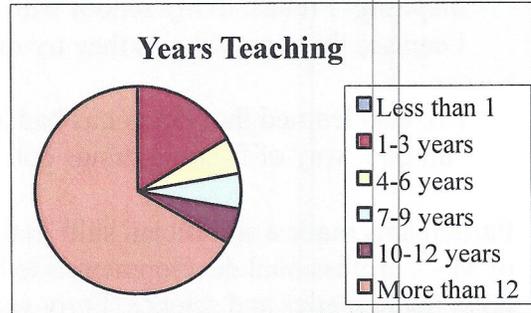
Qualitative data collection methods included:

- Focus group interview of MSA Core participants
- Individual teacher interviews
- Principal interviews
- Teacher reflections.

**Chart 1. Race/Ethnicity for Group 2**



**Chart 2. Years Teaching for Group 2**



- Most MSA participants are experienced teachers. Over two-thirds of the participants in Group 2 have been teaching for more than 12 years, half have attained Level 3 licenses, and 68% of participants hold a Master's degree.

**Key findings for Question #2a:** To what extent did MSA PD influence participants' beliefs and attitudes for teaching mathematics and science?

- Participants realized important changes in their beliefs about how children learn mathematics and of their own understandings of mathematics concepts. Teachers recognized a shift in their ideas, away from a traditional algorithmic approach toward a more conceptual understanding.

At first I had a difficult time solving problems the MSA way because it was pounded to my head all my life the traditional vertical way of problem solving. MSA really takes you back and makes you unwrap what you've learned. I'm coming to that realization that there is a different way of looking at math.

I know I'm not going to go back to teaching that traditional way, I've been given the tools to make that change and to make that difference in student learning

Rather than just coming up with the answer, we're learning how to really get to that answer and we learning how to instill that in our kids, where metacognitively they're able to problem solve on their own.

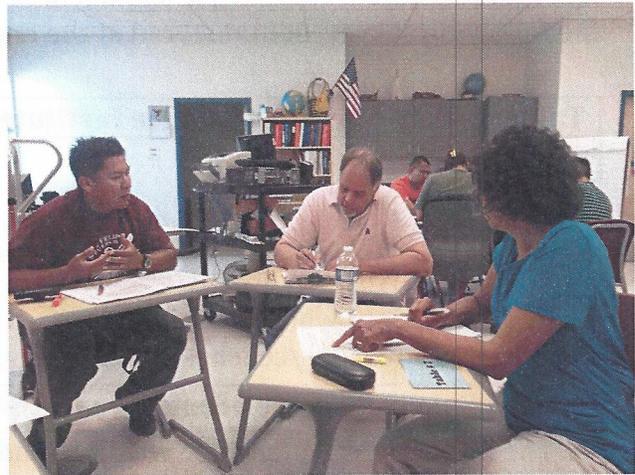
One of the things that happened with MSA is that the first two weeks we became a microcosm of the classroom. We *were* the classroom, we *were* the kids in the classroom and all of sudden you could really understand where the students were and could relate to their learning (focus interview 6/13).

- After participating in an MSA summer institute and follow-up coaching, teachers in both cohorts feel more confident about teaching math and science.

This program has helped us stretch our thinking about how to teach and not be afraid. To me it's given me more confidence to think outside the box. I feel confident about my ability to strengthen my lesson implementation. I know I can tighten up the launch portion so that I might truly get into the exploration. I now want to further enhance my student's learning by providing the opportunity to summarize the learning.

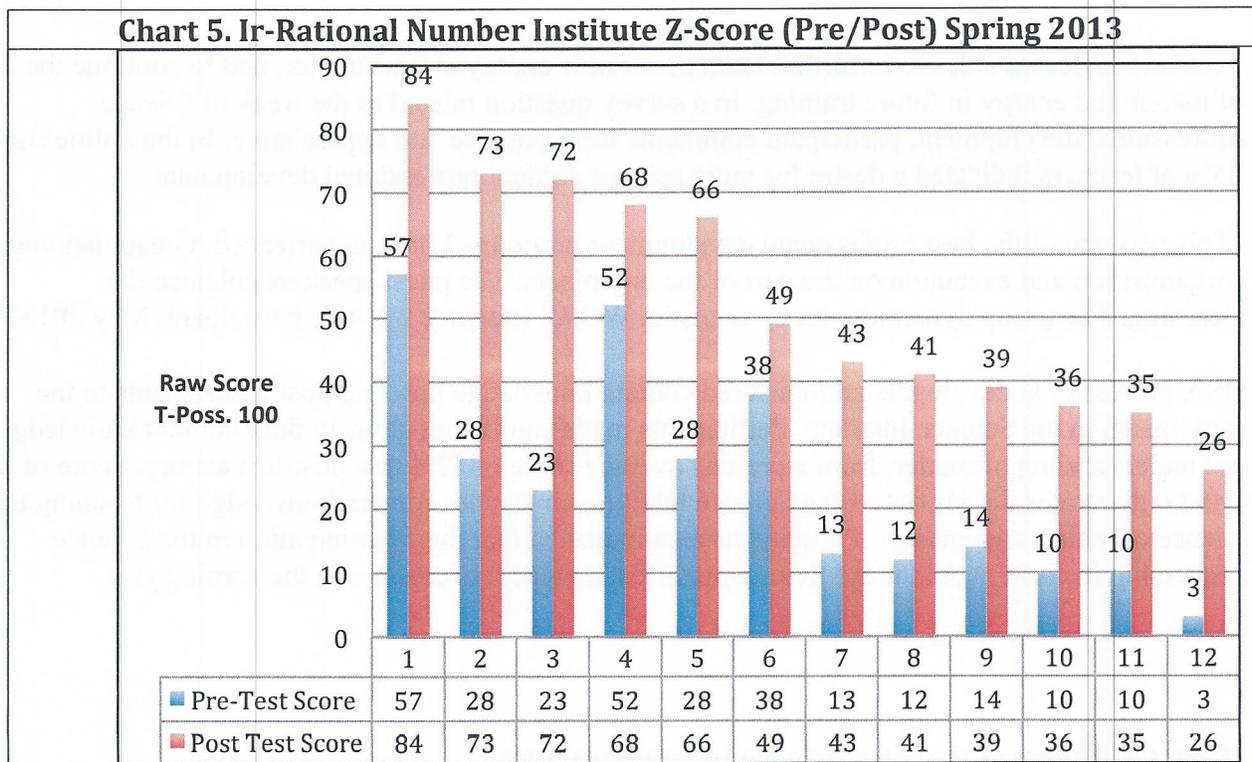
**Key findings for Question #2b:** To what extent did MSA influence teacher content knowledge in mathematics and science?

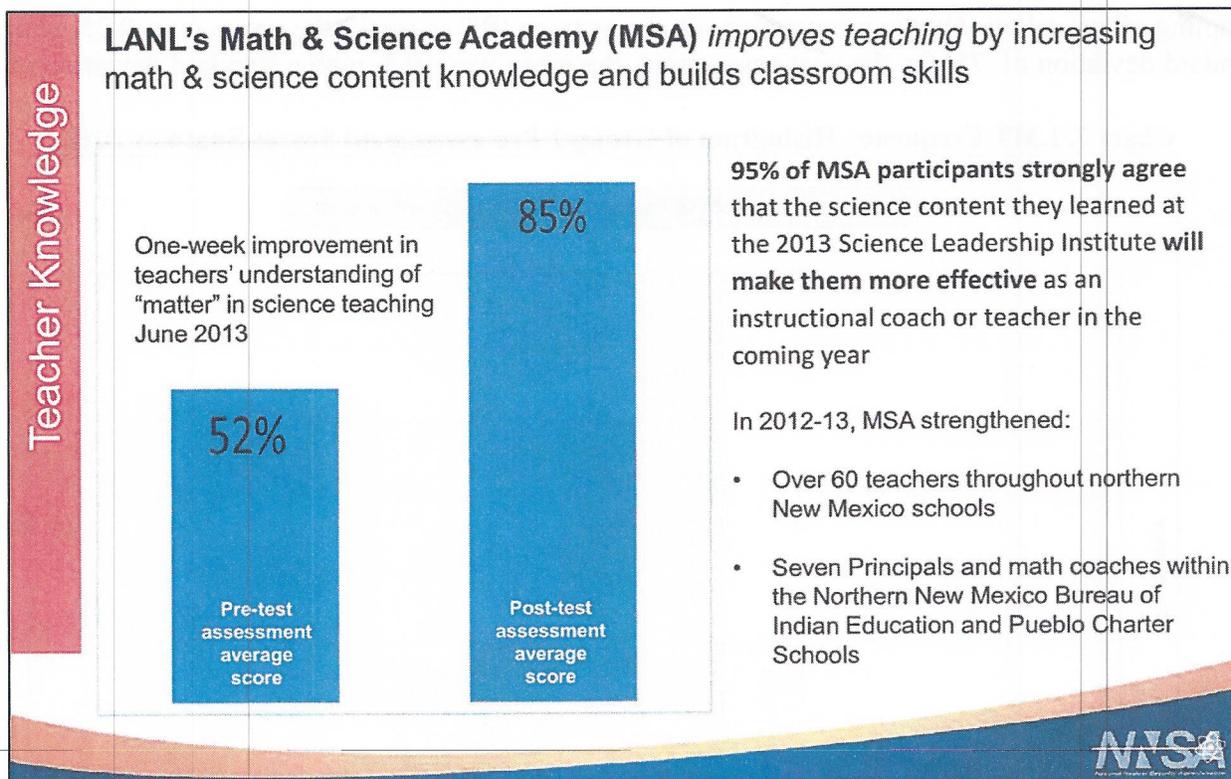
All MSA activities were designed to help teachers increase their content knowledge for teaching mathematics and science. Participants engaged with core mathematical ideas in the Ir-Rational Numbers Institutes, which spanned 40 hours of professional development focused on content and teaching strategies for concepts of number sense and algebra. The weeklong intensive Science Institute focused on building teachers' pedagogical content knowledge on the concept of matter and energy. And the MSA Core Summer Institute included a week of Math-Citement with instructor Dr. Rick Kitchen. Quantitative and qualitative data was collected for each of these activities.



- Ir-Rational Numbers participants showed significant increases in mathematical content knowledge on a pre/post assessment, with a mean gain of 29 points. The mean pre-test raw score 24, and the mean post-test raw score was 53. Chart 5 compares pre/post assessment scores for the 12 participants who took both assessments. The average difference in pre/post scores is 28.67 points, and every participant made gains.

The z-score mean was about the same for pre-and post-assessments ( $z=-.33$  and  $z=-.37$  respectively), indicating that the group as a whole improved by 33% of 1 standard deviation—indicating that the whole group moved toward greater content knowledge for teaching mathematics.





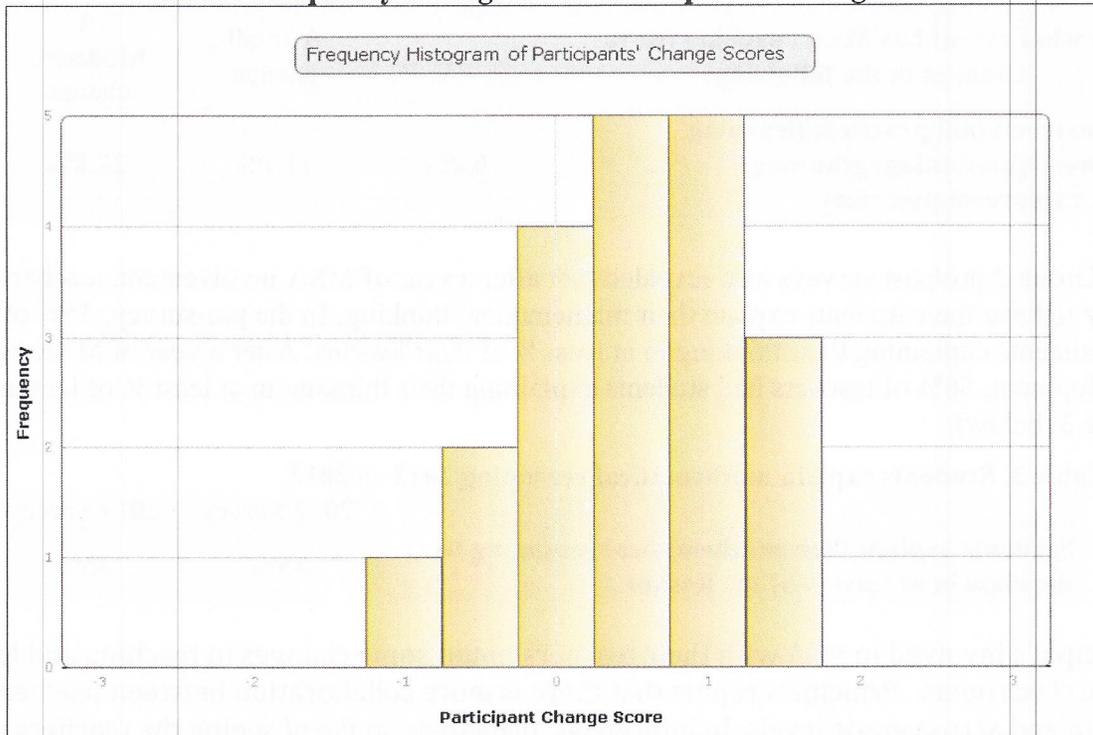
- The MSA Core program, with the Summer Institute and continued coaching support, resulted in measurable gains in content knowledge for teaching mathematics, as measured by the Learning Mathematics for Teaching (LMT) assessment developed at the University of Michigan School of Education<sup>2</sup>. The online assessment is designed to evaluate the mathematical knowledge needed for teaching, and how such knowledge develops as a result of experience and professional learning. Group 2 participants were given the LMT pre-assessment in the summer of 2012, and then took the post-assessment in the summer of 2013. Teachers made significant gains (Cohen's  $d = .68$ ) in their content knowledge for teaching mathematics. The following three Item Response Theory (IRT) *histogram* charts represent this progress. IRT uses statistical techniques to model the association between a student's responses to test items and the underlying latent trait (i.e., ability) that is measured by the items.

Chart 7 shows the span of teacher content knowledge on the pre-assessment in June of 2012. Note how many teachers fall over one standard deviation below the mean. In fact, the mean (Item Response Theory) IRT score is negative (-.25). Chart 8 indicates teacher content knowledge after being in the MSA program for a year. The mean has improved to a +.29. This represents a significant gain.

Chart 9 represents the "change scores", or how much participants grew over the year. The average change was .55 standard deviations. This is significant at the .68 level. The assessment uses IRT (item-response theory) scores, which treat the difficulty of each item (the ICCs) as information to be incorporated in scaling items. The midline, or "0" represents the average ability parameter for a large

<sup>2</sup> LMT assessments were piloted with over 2000 teachers, yielding information about reliability and item characteristics. They are suitable for use in evaluations of content-focused professional development, studies examining teacher learning from pre-service coursework, new curriculum materials, or experience, and projects exploring the contribution of teacher knowledge to student achievement (LMT website: <http://sitemaker.umich.edu/lmt/about>)

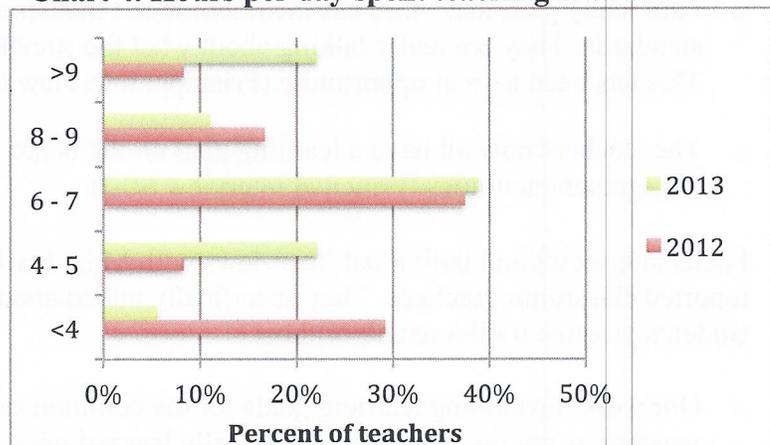
**Chart 9. Frequency Histogram of Participants' Change Scores**



**Key findings for Question #2c:** To what extent did MSA PD influence participants' reported instructional practices?

- MSA participants have significantly increased the amount of time they spend teaching mathematics each week (See Chart 4). The survey indicates that there was a major shift in the amount of time teachers are teaching mathematics. Most significant is the drop in the number of teachers who teach less than four hours of math a week. The majority of those moved to teach 4-5 hours a week, and some increased to more than six. Interview data supports survey data as teachers report feeling more comfortable and confident to teach math.

**Chart 4. Hours per day spent teaching mathematics**



- Group 2 participant pre/post surveys also indicated that the MSA training, accompanied by regular coaching visits by MSA coaches, has led to a change in instructional practices, including learning objectives, questioning techniques, grouping, and lesson implementation strategies of launch, explore, summarize. Table 2 indicates that 89% of teachers experiences a moderate to large change in their instructional practices between 2012 and 2013.

the learning goal and writing at least three things what they've learned inside a learning goal journal (Jemez teacher, 4/13).

- The better I understand, the deeper and more meaningful my instruction becomes. (San Felipe teacher - 4/13)
- I will say that after participating in MSA and several Irrational Number Institutes, my knowledge base grew and I felt that along with it, so did my confidence. I had a better understanding of a few procedures and more importantly, when to apply them (San Felipe teacher, 4/13).
- Now I am making sure that the lesson is aligned with the goal and then tying the formative assessment to that so that I can see how well they master the goal. This is a big change for me (San Felipe teacher, 6/13).
- When I taught them (fifth-grade students) before, I was blaming them. They're not studying; half the class is flunking; yet I taught it! Not even realizing that 'Hey,' it's me – my teaching! I used to just tell them how to solve a problem. Now I make sure that it's all aligned with the learning goal, and then I tie the formative assessment to that so that I can see how well they master the goal (Española teacher, 5/13).
- The coaching combined with the requirement that teachers videotape themselves teaching a lesson was a noteworthy change agent for teacher practice.
  - My coach visited once a month, plus calls and texts and e-mails. It really kept me on track, to focus on the GANAS<sup>3</sup> strategies.
  - It (*video-taping*) does really make you reflect – see things in your teaching that you don't even realize you're doing.
- Even strong teachers felt that the coaching and the video reflections were important change agents to improve their teaching.
  - I think I'm a good teacher but I think I'm also at a point where I'm ready to move forward. Now I feel like I know how to run my classroom, I know how to do all these things but I want to move a little bit further now. Now I can go back to that reflective time and reflect through the videos and the coaching on my own teaching (Española teacher, 6/13).

**Key findings for Question #3a:** To what extent has the MSA program had an impact on systemic reform and capacity building of mathematics/science teaching and learning in the local school district and school unit?

One of the MSA goals is to improve school-based policies and practices that support research-based math and science instruction and a collaborative culture of shared responsibility for student learning.

- Española (Group 1) has had a number of MSA-trained teachers move into school leadership roles, where they have their teachers working in grade-level teams to continually reinforce best practices in mathematics and science teaching. Currently in Española schools, there are three MSA trained

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<sup>3</sup> GANAS is the rubric that MSA introduced to guide inquiry teaching. The acronym stands for Goals, Access prior knowledge, New information, Application of new information, and Summarize.

The ultimate goal of teacher professional development is to improve student learning and achievement. However, research shows that it is difficult to tie professional development activities to student achievement, especially in the short term, as it takes time and sustained support for changes in teaching practice that result in improved student achievement. Two measures of student achievement to look at over time are the New Mexico Standards Based Assessment, given once each year in the spring, and the NWEA short cycle assessments, given three times a year. In Española Schools, where Group 1 involved over 300 teachers over 12 years, there is longitudinal evidence that student performance on the State Standards Based Assessment (SBA) is improving, as indicated in Table 5 below. For Group 2, in their first year of MSA, student assessment data will be considered baseline data.

- In three Española schools (Group 1) where a majority of teachers have participated in the MSA Core program, and where principals have requested MSA support for mathematics writing across all grades, there has been steady documented improvement in student scores on the SBA Short Answer and Open-Ended Questions. Table 5 reflects student performance by grade level at each of the three schools, compared to the entire Española district and the state. The scores below are the average points earned for questions that required students to write either a short explanatory answer (SA), or that were open-ended (OE), requiring students to explain with words, number sentences and drawings that reveal a deep conceptual understanding of the problem.

**Table 5. 2012-2013 SBA Assessment Short Answer and Open-Ended Questions**

3rd Grade Average Pts. Earned						
School Year	TEQ Elem	Abiquiu Elem	San Juan Elem.	Española District	N. M. State	# Pts Poss.
2010-11	9.07	16.86	15.31	11.51	12.04	34
2011-12	9.70	15.29	16.67	12.38	12.15	34
2012-13	11.67	12.71	15.78	12.52	11.95	34
AVG	10.15	14.95	15.92	12.14	12.05	
4th Grade Average Pts Earned						
School Year	TEQ Elem	Abiquiu Elem	San Juan Elem.	District	N. M. State	# Pts Poss.
2010-11	7.02	7.26	9.12	7.94	11.06	34
2011-12	9.34	13.24	15.98	11.19	11.41	34
2012-13	9.17	6.92	14.95	9.92	10.83	34
AVG	8.51	9.14	13.33	9.68	11.10	
5th Grade Average Pts Earned						
School Year	TEQ Elem	Abiquiu Elem	San Juan Elem.	District	State	# Pts Poss.
2010-11	6.60	11.09	13.02	10.86	12.46	38
2011-12	7.07	8.33	11.14	9.47	10.76	38
2012-13	8.74	12.64	13.81	11.39	11.94	38
AVG	7.48	10.69	12.67	10.57	11.72	
6th Grade Average Pts Earned						
School Year	TEQ Elem	Abiquiu Elem	San Juan Elem.	District	State	# Pts Poss.
2010-11	7.53	8.18	12.08	10.59	11.32	38
2011-12	8.73	12.16	13.35	11.28	11.30	38
2012-13	9.12	16	12.88	11.83	12.69	38
AVG	8.46	12.11	12.77	11.20	11.77	

**Key findings for Question #5:** How can the MSA program be refined to better support and enhance teacher professional development, administrative leadership, and student learning and achievement?

MSA is a comprehensive, ongoing professional development effort. The MSA team has reflected on the data from annual evaluation reports and from ongoing formative assessment processes to continually improve their program delivery. As with past evaluations, this evaluation finds that their work with teachers, coaches, and school administrators has had a lasting impact on the teaching and learning of mathematics and science in a number of northern New Mexico schools and classrooms. Implications from a careful analysis of both qualitative program data and quantitative data suggests that participants are both challenged and stimulated by their MSA experience. In the \_\_\_\_\_ of continuous improvement, the following recommendations are given.

- Continue to emphasize formative assessment. Formative assessment involves a change in “classroom culture”—with teachers and students moving into rather different roles from those common in most classrooms. Students engage in “productive struggle” with rich challenging tasks. Resolution comes only gradually through interactions and discussion in the lesson as students gain new facets of connected understanding (Mathematics Assessment Project 2013).

MSA participants have come to appreciate the need to use formative assessment data to evaluate students’ understanding of mathematical concepts and skills and their ability to use the “mathematical practices” described in the Common Core State Standards.

One of my goals coming into this summer’s institute was to develop my knowledge of assessment. The importance and power of formative assessment was communicated effectively so that it continues to be, perhaps, my major teaching goal for the year. Our work developing learning goals for the common core standards will help me know whether or not my students have actually learned what they are supposed to (Jemez teacher, spring 2013 reflection).

- Share evaluation data with MSA participants. It is both formative and summative data that reflects their growth and change. The information could be a powerful reflection/discussion tool. Additionally, looking at data on their own progress models the very practices that MSA espouses as best instructional practice.
- Coaching/modeling continue to be key aspects of the MSA professional development. Teachers feel both supported and pushed by the MSA coaches to implement the strategies and best practices of inquiry-based teaching and learning. Coaching has the most impact on teacher practices when it includes opportunities for teachers to reflect on the teaching learning experiences in their classrooms with other educators.
- Videotaping teachers’ lessons was a key strategy for helping teachers to see their own practices with some objectivity. It was a powerful tool for self-reflection. Reflection is key to self-awareness and changing practice. “It (*videotaping*) does really make you reflect—see things in your teaching that you don’t even realize you’re doing” (April 2013). Emphasizing this point, another teacher, initially nervous about being videotaped, later said that it helped her to see when students disengaged from the lesson.
- The MSA activities that promote reflective practice include coaching, videotaping, collegial conversations, and online reflection requirements. Participants felt that some of their greatest growth