Arizona Mathematics and Science Partnership Statewide Program Evaluation

2013-2014 Teacher Outcomes Report

LeCroy & Milligan
ASSOCIATES, INC.

Arizona Mathematics & Science Partnership
2013-2014 Teacher Outcomes Report

Submitted to:
Arizona Department of Education
Mathematics Standards Implementation
1535 West Jefferson Street – Bin #5
Phoenix, AZ 85007

Submitted by:
LeCroy & Milligan Associates, Inc.
2020 N. Forbes Blvd. Suite 104
Tucson, AZ 85745
Ph: (520) 326-5154
Fax: (520) 326-5155
www.lecroymilligan.com

Acknowledgments:
This evaluation report represents the efforts of many individuals and many collaborating organizations. The evaluation team for the Arizona Mathematics and Science Partnership Statewide Program Evaluation that contributed to this report includes evaluators Darlene Lopez, MA., Steven Wind, Ph.D., and Jenny McCullough Cosgrove, M.S.W. We extend appreciation to Suzi Mast at the Arizona Department of Education for her guidance and support. Thank you to the local evaluators and project staff, who have evaluated the effectiveness of their professional development programs.

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Founded in 1991, LeCroy & Milligan Associates, Inc. is a consulting firm specializing in social services and education program evaluation and training that is comprehensive, research-driven and useful. Our goal is to provide effective program evaluation and training that enables stakeholders to document outcomes, provide accountability, and engage in continuous program improvement. With central offices located in Tucson, Arizona, LeCroy & Milligan Associates has worked at the local, state and national level with a broad spectrum of social services, criminal justice, education and behavioral health programs.

Suggested Citation:
Arizona Mathematics & Science Partnership 2013-2014 Teacher Outcomes Report, LeCroy & Milligan Associates, Inc. (2015).

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List of Exhibits

Introduction

This statewide outcome report for the Arizona Mathematics and Science Partnership (MSP) is based on data provided by seven Mathematics Projects and five Science Projects to the Arizona Department of Education (ADE) for the 2013 – 2014 funding cycle. All seven Mathematics Projects used the Intel Math curriculum. The Science Projects each used a different custom designed curriculum for their professional development. The data for the Mathematics Projects presented in this report comes from the teacher content knowledge assessments, the Learning Mathematics for Teaching (LMT) and the Intel Math Content (IMC) Assessment. The data for the Science Projects presented in this report comes from the Diagnostic Teacher Assessment of Mathematics and Science (DTAMS). In addition to the content knowledge assessments, classroom practice observations using the Reformed Teaching Observation Protocol (RTOP) were submitted for the participant teachers.

This report addresses the following questions from the statewide evaluation that relate to the aggregated teacher knowledge outcomes and classroom practice outcomes.

- What is the quality and completeness of the data set for 2013-2014?
- What are the distributions, descriptions of central tendency, ranges, and frequency of scores within each content area and subtopic, and for pooled participant teachers vs. pooled comparison teachers?
- What patterns and trends are emerging from the content knowledge assessments and the RTOP teacher impact data (content knowledge and classroom practice)?

This report is organized into four sections. The first section reports on content knowledge assessment data collected from the two year and one year Mathematics Projects; the second section presents content knowledge assessment data for the Science Projects; the third reviews data from the RTOP; and the final section provides an overall summary of the MSP teacher outcomes data for 2013-2014.

Mathematics Projects Teacher Outcomes Data

In this section on teacher outcomes data for the Mathematics Projects, data is presented separately for elementary school teachers and middle school teachers because they take different versions of the LMT and IMC based on the grade levels they teach. This report covers the pre, interim (if applicable) and post content knowledge assessments collected by sites. The IMC data contains interim assessments and the LMT does not. Five Mathematics Projects were two year projects (2012-2014 project year). Two Mathematics Projects were one year projects (2013-2014) project year.

Within this section, there are five sub-sections that include:

1. An overview of MSP Mathematics participant and comparison teacher groups;
2. A description of participant and comparison teacher demographic data;
3. An analysis and discussion of data for elementary school teacher groups;
4. An analysis and discussion of data for middle school teacher groups; and
5. A summary of MSP Mathematics teacher outcomes.

There are seven MSP Mathematics Projects in the 2013– 2014 funding cycle. Two of the projects were one year projects:

- Mathematics for Teachers (M4T) – Parker Unified School District
- Intel Math Project at Canyon Country – Coconino County Education Services Agency

Five of the projects were two year projects:

- Chandler Intel Mathematics Academy RTI – Chandler Unified School District
- High Country Intel Math Project (HCIMP) – Coconino County Education Service Agency
- Navajo County Intel Math Project - Navajo County Education Service Agency
- TUSD K8 MSP Project – Tucson Unified School District
- West Central Intel Math Project – Yavapai-Yuma County Education Service Agency

Mathematics Participant and Comparison Teacher Overview

All projects were required to recruit both participant and comparison teachers. Participant teachers are considered retained in the project if they have completed at least 90% of the professional development offered and complete a pre and post-test. A comparison teacher is considered retained if they have completed both the pre and post content knowledge assessment.

For the one year study from 2013-2014, a total of 129 of teachers recruited met this criterion, 117 in elementary school and 12 in middle school. Out of the 71 participant teachers recruited, 63 (88.7%) had both a pre and one year post-test assessment completed. Though only 62 teachers completed 90% of professional development, data provided included 63 teacher scores. This data may include one teacher leader's score. Of the 68 comparison teachers recruited, 66 (95.7%) had both a pre and two year post-test assessment (Exhibit TO1).

For the two year study from 2012-2014, a total of 294 of teachers recruited met this criterion, 214 in elementary school and 80 in middle school. Out of the 221 participant teachers recruited, 149 (67%) had both a pre and two year post-test assessment completed. Of the 199 comparison teachers recruited, 145 (73%) had both a pre and two year post-test assessments (Exhibit TO2). This report only utilizes data from the teachers with matching pre and post content knowledge assessments for analysis.

Exhibit TO1. Teachers with Both Pre and One Year Post Content Knowledge Assessments, 2013-2014 Teacher Outcomes Report

	Participants with Both Assessments	Comparisons with Both Assessments	Total with Both Assessments
Elementary School	58	59	117
Middle School	5	7	12
Total Pre-Post Assessments	**63**	**66**	**129**

Exhibit TO2. Teachers with Both Pre and Two Year Post Content Knowledge Assessments, 2012-2014 Teacher Outcomes Report

	Participants with Both Assessments	Comparisons with Both Assessments	Total with Both Assessments
Elementary School	102	112	214
Middle School	47	33	80
Total Pre-Post Assessments	**149**	**145**	**294**

Mathematics Participant and Comparison Teacher Demographics

Key demographic and teaching-related characteristics that are used by the Mathematics programs as potential matching variables are shown in Exhibit TO3 and TO4. These data are distinguished by elementary school and middle school teachers as the assessments are different based on grade level taught. The total group distributions are also listed. There was a statistically significant difference in gender distribution between elementary school participant and comparison teachers. No other statistically significant relationships were found between the elementary teacher groups. No statistically significant differences were found between participant and comparison teachers at the middle school level.

For the one year study (Exhibit TO3), the majority of participant teachers with reported demographics are female 89.2% of reported elementary and 69.7% of reported middle school). Participant teachers are experienced educators as approximately 75% have five or more years of reported teaching experience. The largest proportion of elementary school participant teachers are currently teaching in the Kindergarten through grade 3 (37.9%), with the next largest proportion teaching in grades 4 and 5 (28.9%). Of middle school participant teachers, 100.0% teach grades 6 through 8. The demographic information was re-sent to evaluators to verify and it appears information was un-reported by some teachers.

For the two year study (Exhibit TO4), the majority of participant teachers are female (85.3% of elementary and 80% of middle school). Participant teachers are experienced educators as approximately 85%% have five or more years of teaching experience. The largest proportion of elementary school participant teachers are currently teaching in the Kindergarten through grade 3 (40.2%), with the next largest proportion teaching in grades 4 and 5 (24.5%). Of middle school participant teachers, 86.7% teach grades 6 through 8.

Exhibit TO3. Teacher Characteristics for One Year MSP Mathematics Projects Participant and Comparison Teachers by School Level, 2013-2014 Teacher Outcomes Report

Characteristic	Elementary School Teachers		Middle School Teachers	
	Participant (N =58)	Comparison (N =59)	Participant (N =5)	Comparison (N =7)
Gender				
Female	33 (56.9%)	39 (66.1%)	2 (40.0%)	5 (71.4%)
Male	11 (19.0%)	4 (6.8%)	1 (20.0%)	0
Unknown	14 (24.1%)	16 (27.1%)	2 (40.0%)	2 (28.6%)
Years Teaching				
<5 years	11 (19.0%)	11 (18.6%)	0	0
5-9 years	14 (24.1%)	17 (28.8%)	0	1 (14.3%)
10-20 years	27 (46.6%)	22 (37.3%)	0	1 (14.3%)
21+ years	6 (10.3%)	8 (13.6%)	2 (40.0%)	1 (14.3%)
Unknown	0	0	3 (60.0%)	4 (57.1%)
Grades Teaching				
K-3	22 (37.9%)	33 (55.9%)	0	0
K-5	2 (3.4%)	0	0	0
K-8	1 (1.7%)	0	0	0
4-5	15 (25.9%)	10 (16.9%)	0	0
4-8	1 (1.7%)	0	0	1 (14.3%)
6-8	1 (1.7%)	9 (15.3%)	5 (100.0%)	6 (85.7%)
6-12	1 (1.7%)	0	0	0
Other	3 (5.2%)	1 (1.7%)	0	0
Unknown	1 (1.7%)	4 (6.8%)	0	0
Number of Mathematics Courses				
0	12 (20.7%)	10 (16.9%)	1 (20.0%)	3 (42.9%)
1	4 (6.9%)	6 (10.2%)	0	0
2	13 (22.4%)	10 (16.9%)	0	
3 or more	14 (24.1%)	16 (27.1%)	1 (20.0%)	2 (28.6%)
Less than 6 hours	1 (1.7%)	1 (1.7%)	0	0
Other/Unknown	14 (24.1%)	16 (27.1%)	3 (60.0%)	2 (28.6%)

Exhibit TO4. Teacher Characteristics for Two Year MSP Mathematics Projects Participant and Comparison Teachers by School Level, 2012-2014 Teacher Outcomes Report

Characteristic	Elementary School Teachers		Middle School Teachers	
	Participant (N = 102)	Comparison (N = 112)	Participant (N = 47)	Comparison (N = 33)
Gender				
Female	87 (85.3%)	103 (92.0%)	38 (80.9%)	24 (72.7%)
Male	7 (6.9%)	4 (3.6%)	6 (12.8%)	9 (27.3%)
Unknown	8 (7.8%)	5 (4.5%)	3 (6.4%)	0
Years Teaching				
<5 years	13 (12.7%)	22 (19.6%)	6 (12.8%)	4 (12.1%)
5-9 years	12 (36.4%)	34 (30.4%)	10 (21.3%)	12 (36.4%)
10-20 years	49 (48.0%)	46 (41.1%)	21 (44.7%)	10 (30.3%)
21+ years	15 (14.7%)	7 (6.3%)	10 (21.3%)	6 (18.2%)
Unknown	3 (2.9%)	3 (2.7%)	0	1 (3.0%)
Grades Teaching				
K-3	41 (40.2%)	55 (49.1%)	25 (53.2%)	8 (24.2%)
K-5	2 (2.0%)	1 (0.9%)	1 (2.1%)	1 (3.0%)
K-8	2 (2.0%)	0	0	1 (3.0%)
4-5	25 (24.5%)	26 (23.2%)	8 (17.0%)	8 (24.2%)
4-8	4 (3.9%)	3 (2.7%)	1 (2.1%)	1 (3.0%)
6-8	22 (21.6%)	24 (21.4%)	11 (23.4%)	13. (39.4%)
6-12	2 (2.0%)	0	1 (2.1%)	0
Other/Unknown	4 (3.9%)	3 (2.7%)	0	1 (3.0%)
Number of Mathematics Courses				
0	6 (5.9%)	11 (9.8%)	1 (2.1%)	0
1	10 (9.8%)	17 (15.2%)	7 (14.9%)	5 (15.2%)
2	36 (35.3%	32 (28.6%)	16 (34.0%)	9 (27.3%)
3 or more	48 (47.1%)	51 (45.5%)	23 (48.9%)	18 (54.5%)
Other/Unknown	0	0	0	0

Elementary School Teachers

Within this section, the content knowledge assessment scores for the Intel Math Content Assessment (IMC), and Learning Mathematics for Teaching (LMT) assessment for elementary school teachers are outlined in Exhibits TO5 through TO6 for one year math projects and Exhibits TO7 through TO19 for two year math projects. The one year math project did not participate in LMT and has only IMC scores. The IMC assessment tool consists of 20 questions: six items on Numbers and Operations; seven on Algebraic Thinking; three on Rate/Proportional Reasoning; and four on Functions. Each question is scored as completely correct (worth 2 points), partially correct (1 point), or not at all correct (0 points). The final score is calculated as the percent of points earned out of total points possible. Thus scores range from 0% to 100%.

One Year Intel Math Content (IMC) Assessment Scores

Mean scores for elementary Mathematics participant and comparison teachers were comparable at pre-test (52.8% vs. 52.1%, respectively; t=.138, p=0.890). At the post assessment the participant teachers scored an average of 64.9%, which was not significantly higher than the comparison teachers' mean score of 61.2% (t=.818, p=.415). When comparing pre- and post-test scores within each teacher group participant teachers and comparison teachers achieved statistically significant gains in IMC scores over time (see Exhibit TO5). Exhibit TO5a shows that there was no significant difference in IMC change scores between participant teachers. Participant teachers achieved a mean score increase of 12.2% over time, while comparison teachers saw an increase of 9.0% points (t=1.017, p=.311). Demonstrating these results, Exhibit TO5b illustrates the mean IMC scores observed at pre and post for both groups.

Exhibit TO5. Elementary School Mathematics IMC Assessment: One Year Pre-Post Score Comparison, 2013-2014 Teacher Outcomes Report

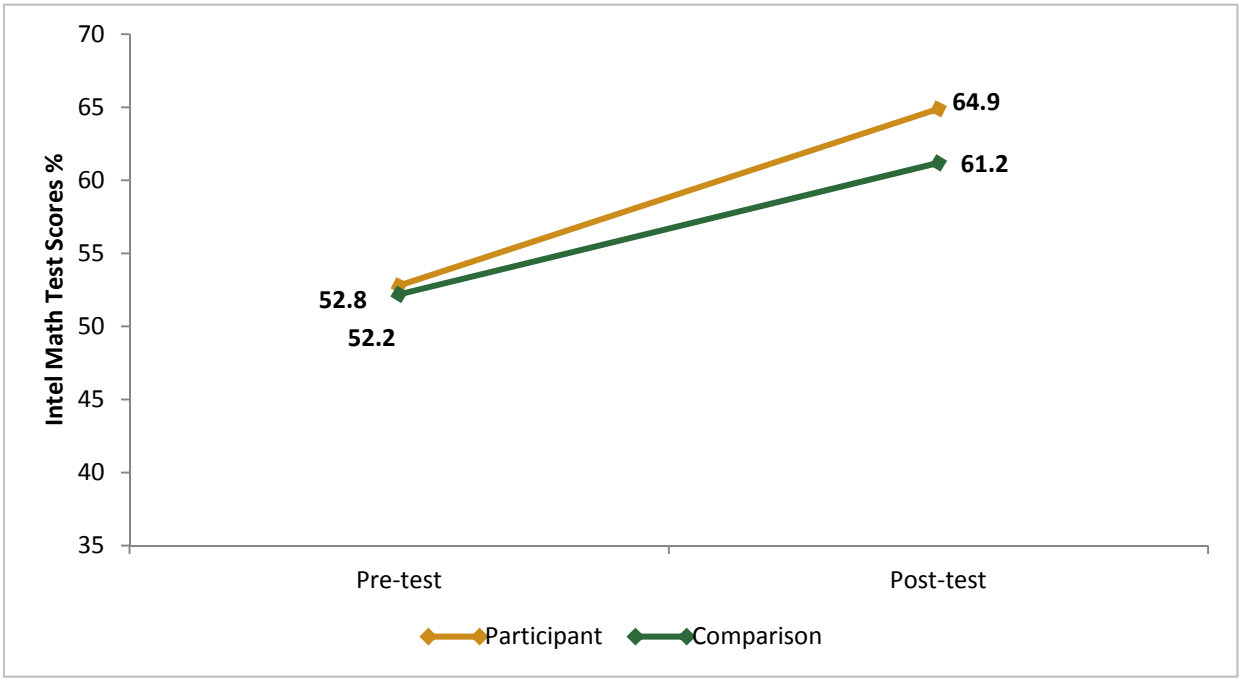
IMC Score	Mathematics Elementary School			
	Participant Teachers (N=58)		Comparison Teachers (N=59)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0%	2.5%	5%	15%
Maximum score	100%	100%	100%	100%
Median score	53.8%	65%	52.5%	61.2%
Mean score	52.76%	64.91%	52.16%	61.19%
Standard deviation	23.34%	25.84%	23.48%	23.39%
Within group pre-post t-test	t=5.815*, p=<.001		t=4.00*, p=<.001	

*Significant at the 0.05 level

Exhibit TO5a. Elementary School Mathematics IMC Assessment: One Year Pre-Post Change Score Comparison, 2013-2014 Teacher Outcomes Report

IMC Change Score (Post Score - Pre Score)	Mathematics Elementary School	
	Participant Teachers (N=58)	Comparison Teachers (N=59)
Minimum change	-20.0%	-25.0%
Maximum change	50.0%	65.0%
Median change	8.8%	5.0%
Mean change	12.2%	9.0%
Standard deviation of change	15.9%	17.3%
Between group Change Score t-test	t=1.017, p=.311	

Exhibit TO5b. Elementary School Mathematics IMC Assessment: One Year Pre-Post Mean Score Comparison, 2013-2014 Teacher Outcomes Report



Two Year Intel Math Content (IMC) Assessment Scores

Mean scores for elementary Mathematics participant and comparison teachers were not significantly different at pre-test (41.2% vs. 46.2%, respectively; t=1.602, p=0.11). At the post assessment there was no significant difference between the participant teachers average score of 52.8%and the comparison teachers' average score of 47.9% (t=3.96, p=3.23). In comparing pre- and post-test scores within each teacher group participant teachers achieved a statistically significant gain in IMC scores over time (Exhibit TO6b), whereas no significant gains were observed for the comparison group.

When examining the IMC scores from pre-test to interim-test (Exhibit TO6) and interim-test to post-test (TO6a), significant gains were made by participant teachers in the first year of the math program. There were then significant declines by math teachers in the second year of the program, though their scores were still significantly higher at the two year post assessment than the pre-test assessment.

Exhibit TO6c shows that a statistically significant difference in IMC change scores was observed between participant teachers. Participant teachers achieved a mean score increase of 11.7 percent over time, while comparison teachers saw an increase of 1.7 percent (t=5.105, p<0.001). Demonstrating these results, Exhibit TO7 illustrates the mean IMC scores observed at pre and post for both groups.

Exhibit TO6. Elementary School Two Year Mathematics IMC Assessment: Pre-Interim Score Comparison, 2012-2014 Teacher Outcomes Report

Pre-Interim IMC Score	Mathematics Elementary School			
	Participant Teachers (N=101)		Comparison Teachers (N=111	
	Pre-test	Interim-test	Pre-test	Interim-test
Minimum score	0%	12.5%	0%	0%
Maximum score	92.5%	100.0%	95.0%	100%
Median score	40.0%	60.0%	47.5%	45.0%
Mean score	41.2%	60.4%	46.2%	47.0%
Standard deviation	22.2%	25.3%	23.4%	20.6%
Within group Pre-Post t-test	t=11.057*, p=<.001		t=.495, p=.621	

*Significant at the 0.05 level

Exhibit TO6a. Elementary School Two Year Mathematics IMC Assessment: Interim-Post Score Comparison, 2012-2014 Teacher Outcomes Report

Interim-Post IMC Score	Mathematics Middle School			
	Participant Teachers (N=101)		Comparison Teachers (N=111)	
	Interim-test	Post-test	Interim-test	Post-test
Minimum score	12.5%	3.0%	0%	2.5%
Maximum score	100.0%	100.0%	100%	95.0%
Median score	60.0%	50.0%	45.0%	45.0%
Mean score	60.4%	53.0%	47.0%	47.9%
Standard deviation	25.3%	25.2%	20.6%	21.0%
Within group Pre-Post t-test	t=5.207*, p=<.001		t=.349, p=.728	

*Significant at the 0.05 level

Exhibit TO6b. Elementary School Two Year Mathematics IMC Assessment: Two Year Pre-Post Score Comparison, 2012-2014 Teacher Outcomes Report

IMC Score	Mathematics Elementary School			
	Participant Teachers (N=101)		Comparison Teachers (N=111)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0%	3.0%	0%	2.5%
Maximum score	92.5%	100%	95.0%	95.0%
Median score	40.0%	50.0%	47.5%	45.0%
Mean score	41.2%	53.0%	46.2%	47.9%
Standard deviation	22.2%	25.2%	23.5%	21.0%
Within group pre-post t-test	t=8.380, p=<.001*		t=1.235, p=.219	

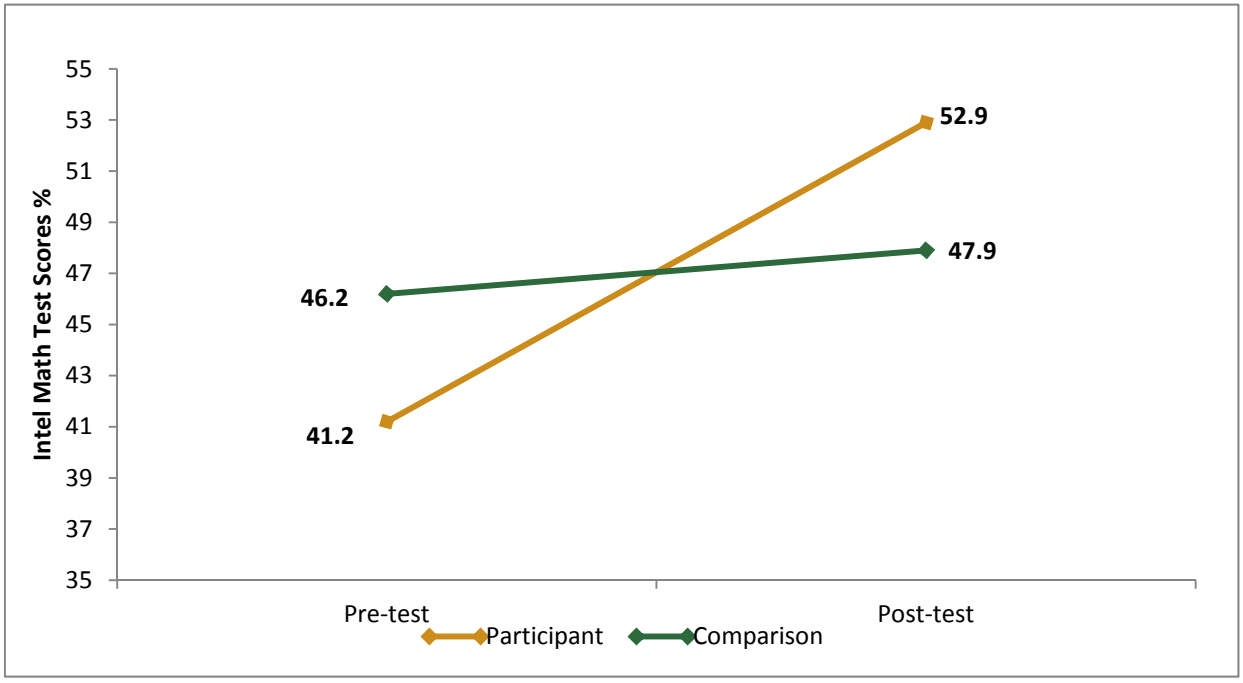
*Significant at the 0.05 level

Exhibit TO6c. Elementary School Two Year Mathematics IMC Assessment: Two Year Pre-Post Change in Score Comparison, 2012-2014 Teacher Outcomes Report

IMC Change in Score (Post Score - Pre Score)	Mathematics Elementary School	
	Participant Teachers (N=101)	Comparison Teachers (N=111)
Minimum change	-45.0%	-30.0%
Maximum change	43.0%	68.0%
Median change	12.5%	0%
Mean change	11.7%	1.7%
Standard deviation of change	14.0%	14.4%
Between group Change Score t-test	t=5.105*, p=<.001	

*Significant at the 0.05 level

Exhibit TO7. Elementary School Two Year Mathematics IMC Assessment: Two Year Pre-Post Mean Score Comparison, 2012-2014 Teacher Outcomes Report



Learning Mathematics for Teaching (LMT) Scores

Two year math projects also completed the Learning Mathematics for Teaching (LMT) assessment. The elementary school LMT has three content sections: Number Concepts and Operations; Geometry; and Patterns, Functions, and Algebra. This year there are a total of 26 Number Concepts and Operations questions, 19 Geometry questions, and 16 Patterns, Functions, and Algebra questions for a total possible score of 61.

Exhibit TO8 shows the results of paired sample t-tests that compared pre and post LMT scores by section and in total for each teacher group. Elementary school MSP Mathematics participant teachers achieved a significant increase from pre to post for all three areas assessed and in total. Comparison teachers showed significant increases in total knowledge scores and in the area of number concepts and operations and the area of geometry.

Exhibit TO8. Elementary School Two Year Mathematics LMT: Paired t-test of Pre-Post Knowledge Score by Teacher Group, 2012-2014 Teacher Outcomes Report

Content Sections	Participant Teachers		Comparison Teachers	
	t	p	t	p
Total Knowledge	11.982	<.001*	2.579	.011*
Number Concepts and Operations	7.458	<.001*	2.690	.0008*
Geometry	9.697	<.001*	2.483	.015*
Patterns, Functions, and Algebra	9.664	<.001*	1.097	.275

*Significant at the 0.05 level

The following report of findings for each LMT sub-section includes two types of analyses:

- An independent-sample t-test was performed to test the difference in average pre and post scores and change scores across the participant and comparison teacher groups; and
- A paired-sample t-test was performed to test the difference in average pre and post scores within each participant and comparison group.

Please note that statistical significance was observed if the p value was ≤ 0.05, indicating that there is a 5% or less possibility that the difference observed between the participant and comparison groups occurred by chance.

LMT – Total Knowledge

Elementary participant teachers scored significantly *lower* than comparison teachers on the LMT Total Knowledge pre-test on average, 26.9 vs. 33.07, respectively (t=4.313, p=<.001) However, no comparable differences were found between the groups on the Total Knowledge LMT post-test, 37.7 vs. 36.4 (t=-.921, p=0.358). Looking at change within groups, a significant change was observed from pre to post for both participant teachers and comparison teachers (Exhibit TO9). Exhibit TO9a shows that participant teachers' average Total Knowledge LMT score significantly improved by 10.9 points from pre to post, as opposed to 2.3 points for comparison teachers (t=-6.624, p<.001). This significant difference is depicted in the line graph shown in Exhibit TO10.

Exhibit TO9. Elementary School Two Year Mathematics LMT: Pre-Post Total Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

Total Knowledge Score	Mathematics Elementary School			
	Participant Teachers (N= 87)		Comparison Teachers (N=100)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	8.0	0	0	13.0
Maximum score	55.0	56.0	54.0	57.0
Median score	26.0	35.0	36.0	37.0
Mean score	26.8	37.7	34.1	36.4
Standard deviation	9.2	9.0	11.3	9.0
Within group pre-post t-test	t=11.982*, p=<.001		t=2.579*, p=<.011	

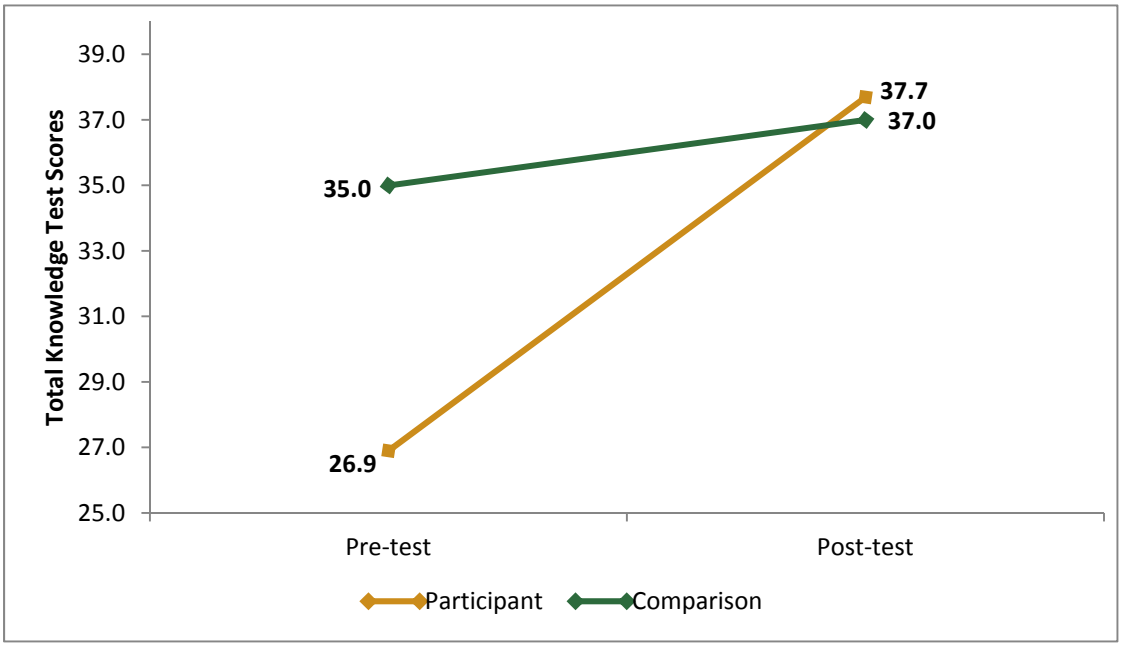
*Significant at the 0.05 level

Exhibit TO9a. Elementary School Two Year Mathematics LMT: Pre-Post Total Knowledge Change Score Comparison, 2012-2014 Teacher Outcomes Report

Total Knowledge Change Score (Post Score-Pre Score)	Mathematics Elementary School	
	Participant Teachers (N= 87)	Comparison Teachers (N=100)
Minimum change	-28.0	-25.0
Maximum change	39.0	49.0
Median change	12.0	2.0
Mean change	10.9	2.3
Standard deviation of change	8.5	9.1
Between group t-test	t=6.24, p=<.001*	

*Significant at the 0.05 level

Exhibit TO10. Elementary School Two Year Mathematics LMT: Pre-Post Mean Total Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Number Concepts and Operations

Elementary school Mathematics participant and comparison teachers did not score significantly differently on the pre-test for the LMT Number Concepts and Operation sub-section (t=1.466, p=.144). At post-test the participant teachers did not have significantly different scores (t=-1.688, p=0.093) than comparison teachers. Comparing change from pre to post (Exhibit TO11), both groups improved significantly. The participant teacher group achieved a significantly greater change score from pre to post than the comparison teachers (t=3.524, p= 0.001; Exhibit 11a). This significant change is demonstrated in Exhibit TO11b, which graphs the average pre-post test results for each group.

Exhibit TO11. Elementary School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Number Concepts and Operations: Pre-Post Score Comparison	Mathematics Elementary School			
	Participant Teachers (N=87)		Comparison Teachers (N=100)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	4.0	0	0	5.0
Maximum score	23.0	26.0	23	24.0
Median score	13.0	16.0	14.5	16.0
Mean score	13.1	16.4	14.1	15.3
Standard deviation	4.6	4.9	5.0	4.2
Within group pre-post t-test	t=7.458*, p=<.001		t=2.690*, p=.008	

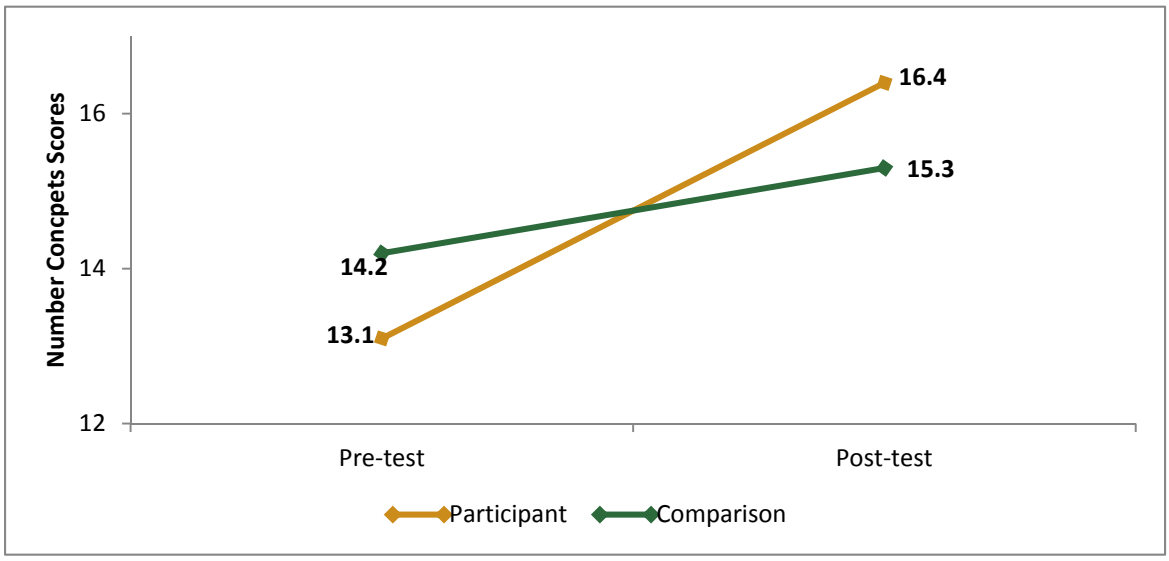
*Significant at the 0.05 level

Exhibit TO11a. Elementary School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Knowledge Change Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Number Concepts and Operations: Change Score (Post Score- Pre Score)	Mathematics Elementary School	
	Participant Teachers (N=87)	Comparison Teachers (N=100)
Minimum change	-16.00	-6.0
Maximum change	13.00	20.0
Median change	3.0	1.0
Mean change	3.3	1.13
Standard deviation of change	4.1	4.2
Between group t-test	t=3.524*, p=.001	

*Significant at the 0.05 level

Exhibit TO11b. Elementary School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Geometry

Elementary school Two Year Mathematics participant teachers had significantly *lower* geometry pre-test scores, on average, than comparison teachers, 8.0 vs. 11.4, respectively (t= 6.101, p<0.001). At post-test, participant teachers had significant gains in average score than comparison groups (t=9.697, p=<.001) and comparison teachers also increased their scores significantly (t=2.483, p=.015; Exhibit TO12a). The pre-post change score analysis shows that the participant teachers had a significant increase over the comparison teachers (t=6.101, p=< 0.001; Exhibit TO12a). Exhibit TO12b illustrates the average pre-posttest differences for the two groups.

Exhibit TO12. Elementary School Two Year Mathematics LMT Geometry: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Geometry: Pre-Post Knowledge Score	Mathematics Elementary School			
	Participant Teachers (N=87)		Comparison Teachers (N=100)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0	0	0	5.0
Maximum score	19.0	19.0	17.0	19.0
Median score	8.0	12.0	11.0	12.0
Mean score	8.0	12.0	11.4	12.2
Standard deviation	3.8	3.1	3.7	3.1
Within group pre-post t-test	t=9.697*, p=<.001		t=2.483*, p=.015	

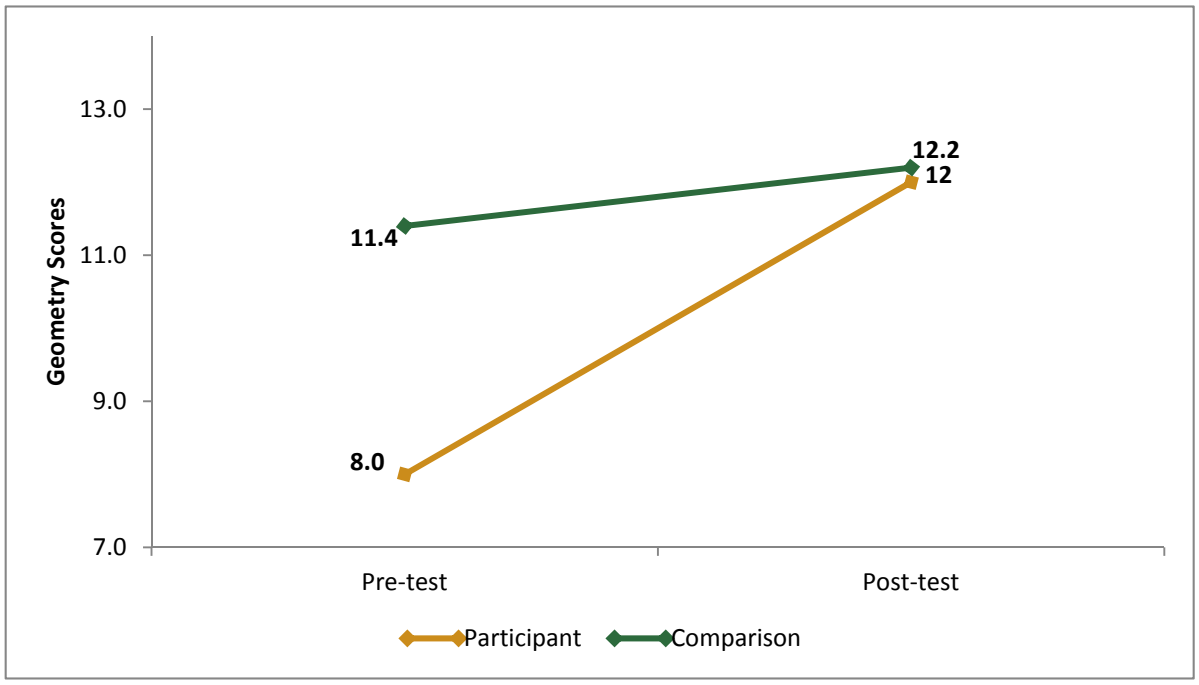
*Significant at the 0.05 level

Exhibit TO12a. Elementary School Two Year Mathematics LMT Geometry: Pre-Post Knowledge Change Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Geometry: Change Score (Post Score- Pre Score)	Mathematics Elementary School	
	Participant Teachers (N=87)	Comparison Teachers (N=100)
Minimum change	-5.0	-8.0
Maximum change	16.0	16.0
Median change	4.0	1.0
Mean change	3.9	.80
Standard deviation of change	3.8	3.22
Between group t-test	t=6.101*, p=<.001	

*Significant at the 0.05 level

Exhibit TO12b. Elementary School Two Year Mathematics LMT Geometry: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Patterns, Functions, and Algebra

For Patterns, Functions, and Algebra tests, elementary MSP participant teachers scored, on average, significantly lower on the pre-test (t=5.656 , p<0.001) with no significant difference on the post-test (t=-.841 , p=0.402) than comparison teachers (Exhibit TO13). Exhibit TO13a shows that participant teachers had significantly greater change scores from pre to post than the comparison teachers (t=6.119, p<0.001). The average pre and post scores for each teacher group are illustrated in Exhibit TO14.

Exhibit TO13. Elementary School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Score	Mathematics Elementary School			
	Participant Teachers (N=87)		Comparison Teachers (N=100)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0	0	0	1
Maximum score	14.0	16.0	16.0	15.0
Median score	5.0	9.0	9.0	9.0
Mean score	5.6	9.3	8.5	8.9
Standard deviation	3.1	3.0	3.8	3.1
Within group pre-post t-test	t=9.664*, p=<.001		t=1.041, p= .275	

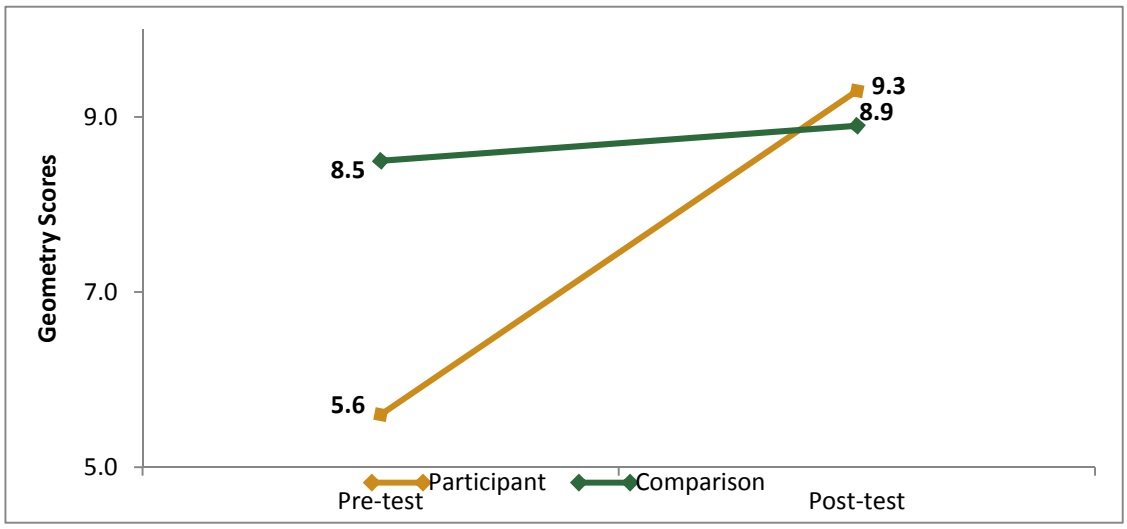
*Significant at the 0.05 level

Exhibit TO13a. Elementary School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Change Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Patterns, Functions, and Algebra: Change Score (Post Score- Pre Score)	Mathematics Elementary School	
	Participant Teachers (N=87)	Comparison Teachers (N=100)
Minimum change	-7.0	-11.0
Maximum change	14.0	13.0
Median change	3.0	1.0
Mean change	3.7	0.4
Standard deviation of change	3.6	3.7
Between group t-test	t=6.119*, p=<.001	

*Significant at the 0.05 level

Exhibit TO14. Elementary School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



MSP Mathematics Middle School Teachers

Within this section, the content knowledge assessment scores for the Intel Math Content Assessment (IMC), and Learning Mathematics for Teaching (LMT) assessment are outlined in Exhibits TO15 through TO31 for middle school teachers. The IMC assessment tool for middle school is of a similar format as the one for elementary school consisting of 20 questions across four areas, as previously noted. Each question is scored as completely correct (worth 2 points), partially correct (1 point), or not at all correct (0 points). The final score is calculated as the percentage of points earned out of total points possible.

One Year Intel Math Content (IMC) Assessment Scores

Due to the small sample size for one year IMC middle school teachers (N=12), nonparametric statistics were run to determine if the distributions of IMC scores differed significantly between the participant teachers and comparison teachers (Exhibit TO15). The Independent-Samples Mann-Whitney U Test found there was not a significant difference in the distributions between the participant teachers and comparison teachers either at pre-test or post-test (Exhibit TO15a). Though the post-test gains by comparison teachers appear to be significantly higher than participant teachers at face value, the statistical testing shows that there is no statistically significant difference between the two groups.

Exhibit TO15. Middle School One Year Mathematics IMC Assessment: Pre-Post Score Comparison, 2013-2014 Teacher Outcomes Report

Pre-Post IMC Score	Mathematics Middle School			
	Participant Teachers (N=5)		Comparison Teachers (N=7)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	20.0%	45.0%	40.0%	40.0%
Maximum score	97.5%	100%	95.0%	100.0%
Median score	55.0%	65.0%	90.0%	97.5%
Mean score	61.0%	70.5%	79.6%	86.4%
Standard deviation	29.5%	22.8%	20.5%	22.7%

Exhibit TO15a. Middle School One Year Mathematics IMC Assessment: Pre-Post Score Distribution Comparisons, 2013-2014 Teacher Outcomes Report

Distribution of Scores Between Groups	Mathematics Middle School	
	Significance	Decision
Pre-Test Assessment Scores	.683	Retain the null hypothesis
Post-Test Assessment Scores	.808	Retain the null hypothesis

Two Year Intel Math Content (IMC) Assessment Scores

Average (mean) scores of middle school MSP Mathematics participant and comparison teachers did not differ significantly at pre-test (65.7% vs. 67.3%, respectively; p=0.746). Participant teachers did show significantly higher gains in scores than comparison teachers at post-test (10.8% vs. 6.0%; t=2.010, p=0.048). Exhibit TO16 and TO16a demonstrate the significant change occurs in scores in the first year of assessment and there is no significant change in the second year of assessment within groups.

Both groups of teachers had statistically significant improved scores from pre to post-test on average (Exhibit TO16b). Similarly, Exhibit TO17 shows that the increase for participant teachers was significantly higher than that of comparison teachers (t=2.010, p=0.048). Average change between pre and post scores by teacher group are displayed in Exhibit TO18.

Exhibit TO16. Middle School Two Year Mathematics IMC Assessment: Pre-Interim Score Comparison, 2012-2014 Teacher Outcomes Report

Pre-Interim IMC Score	Mathematics Middle School			
	Participant Teachers (N=45)		Comparison Teachers (N=33)	
	Pre-test	Interim-test	Pre-test	Interim -test
Minimum score	20.0%	10.0%	15.0%	22.50%
Maximum score	100.0%	100.0%	100.0%	100.0%
Median score	67.5%	85.0%	75.0%	75.0%
Mean score	65.7%	78.4%	67.3%	70.9%
Standard deviation	19.7%	20.6%	22.1%	21.4%
Within group Pre-Post t-test	t=3.279*, p=.002		t=3.081*, p=.005	

*Significant at the 0.05 level

Exhibit TO16a. Middle School Two Year Mathematics IMC Assessment: Interim-Post Score Comparison, 2012-2014 Teacher Outcomes Report

Interim-Post IMC Score	Mathematics Middle School			
	Participant Teachers (N=45)		Comparison Teachers (N=33)	
	Interim-test	Post-test	Interim-test	Post-test
Minimum score	10.0%	37.5%	22.50%	17.5%
Maximum score	100.0%	100.0%	100.0%	100.0%
Median score	85.0%	77.5%	75.0%	80.0%
Mean score	78.4%	76.5%	70.9%	73.3%
Standard deviation	20.6%	17.2%	21.4%	20.6%
Within group Pre-Post t-test	t=-0.570, p=.572		t=.261, p=.796	

*Significant at the 0.05 level

Exhibit TO16b. Middle School Two Year Mathematics IMC Assessment: Pre-Post Score Comparison, 2012-2014 Teacher Outcomes Report

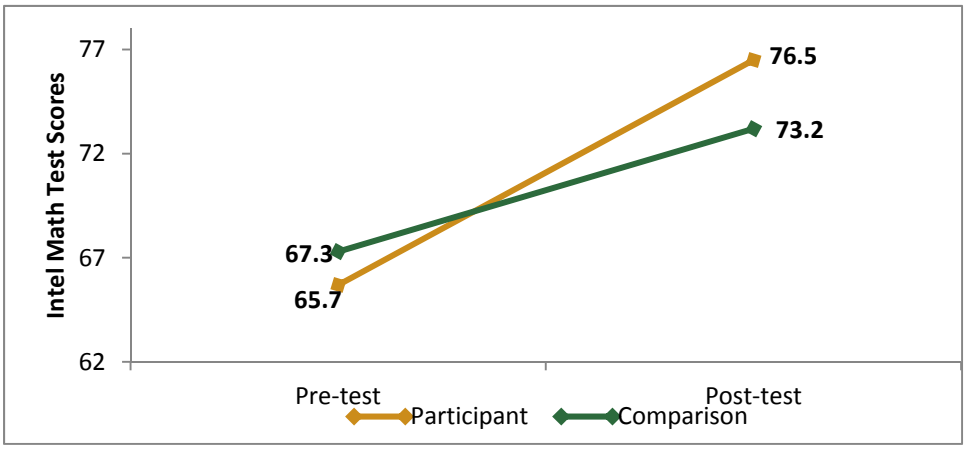
Pre-Post IMC Score	Mathematics Middle School			
	Participant Teachers (N=45)		Comparison Teachers (N=33)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	20.0%	37.5%	15.0%	17.5%
Maximum score	100.0%	100.0%	100%	100%
Median score	67.5%	77.5%	75.0%	80%
Mean score	65.7%	76.5%	67.3%	73.2%
Standard deviation	19.7%	17.2%	22.1%	20.6%
Within group Pre-Post t-test	t=5.585*, p=<.001		t=4.270*, p=<.001	

*Significant at the 0.05 level

Exhibit TO17. Middle School Two Year Mathematics IMC Assessment: Pre-Post Change Score Comparison, 2012-2014 Teacher Outcomes Report

IMC Change Score (Post Score- Pre Score)	Mathematics Middle School	
	Participant Teachers (N=45)	Comparison Teachers (N=33)
Minimum change	-17.0%	-10.0%
Maximum change	43%	28%
Median change	10.0%	5.0%
Mean change	10.8%	6.0%
Standard deviation of change	12.9%	8.1%
Between group Change Score t-test	t=2.010*, p=0.048	

Exhibit 18: Middle School Two Year Mathematics IMC Assessment: Pre-Post Change Score Comparison, 2012-2014 Teacher Outcomes Report



Two Year Learning Mathematics for Teaching (LMT) Scores

As with the Elementary School, two year middle school math projects also completed the Learning Mathematics for Teaching (LMT) assessment. The Middle School LMT assessment has three content sections: Number Concepts and Operations; Geometry; and Patterns, Functions, and Algebra. This year there are a total of 17 Number Concepts and Operations questions, 19 Geometry questions, and 29 Patterns, Functions, and Algebra questions for a total possible score of 65.

Exhibit TO19 shows that middle school MSP Mathematics participant teachers achieved a statistically significant improvement in average scores from pre to post-testing for LMT total knowledge and all three sub-sections. On the other hand, comparison teachers showed significant change in average LMT scores for total knowledge and the one sub-section of Geometry.

Exhibit TO19. Middle School Two Year Mathematics LMT: Paired t-test of Pre-Post Knowledge Score by Teacher Group, 2012-2014 Teacher Outcomes Report

Content Sections	Participant Teachers		Comparison Teachers	
	t	p	t	p
Total Knowledge	8.874*	<.001	2.543*	.017
Number Concepts and Operations	5.264*	<.001	1.840	.077
Geometry	9.511*	<.001	2.675*	.013
Patterns, Functions, and Algebra	4.995*	<.001	1.142	.264

*Significant at the 0.05 level

The following report of findings for each LMT sub-section includes two analyses:

- An independent-sample t-test was performed to test the difference in average pre and post scores and change scores across the participant and comparison teacher groups; and
- A paired-sample t-test was performed to test the difference in average pre and post scores within each participant and comparison group.

Please note that statistical significance was observed if the p value was ≤ 0.05, indicating that there is a 5% or less possibility that the difference observed between the participant and comparison groups occurred by chance.

LMT – Total Knowledge

The pre LMT–Total Knowledge scores differed significantly between middle school participant and comparison teachers (t=4.800, p=0.001). Though both participant and comparison teachers showed significant increases from pre-test to post-test (TO20), the two groups did not significantly differ from each other at two year post-test (t=.231, p=.818). The participant teachers showed a statistically significantly greater increase from pre to post assessment on average than the comparison teachers (Exhibit TO21). Average pre and post-test scores by teacher group are shown in Exhibit TO22.

Exhibit TO20. Middle School Two Year Mathematics LMT: Pre-Post Total Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT: Pre-Post Total Knowledge Score	Mathematics Middle School			
	Participant Teachers (N=40)		Comparison Teachers (N=27)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	6.0	26.0	9.0	15.0
Maximum score	50.0	56.0	60.0	64.0
Median score	27.0	40.5	38.0	42.0
Mean score	27.7	40.4	37.1	41.0
Standard deviation	8.9	7.5	13.0	11.6
Within group Pre-Post t-test	t= 8.874*,p=<.001		t=2.543*, p= .017	

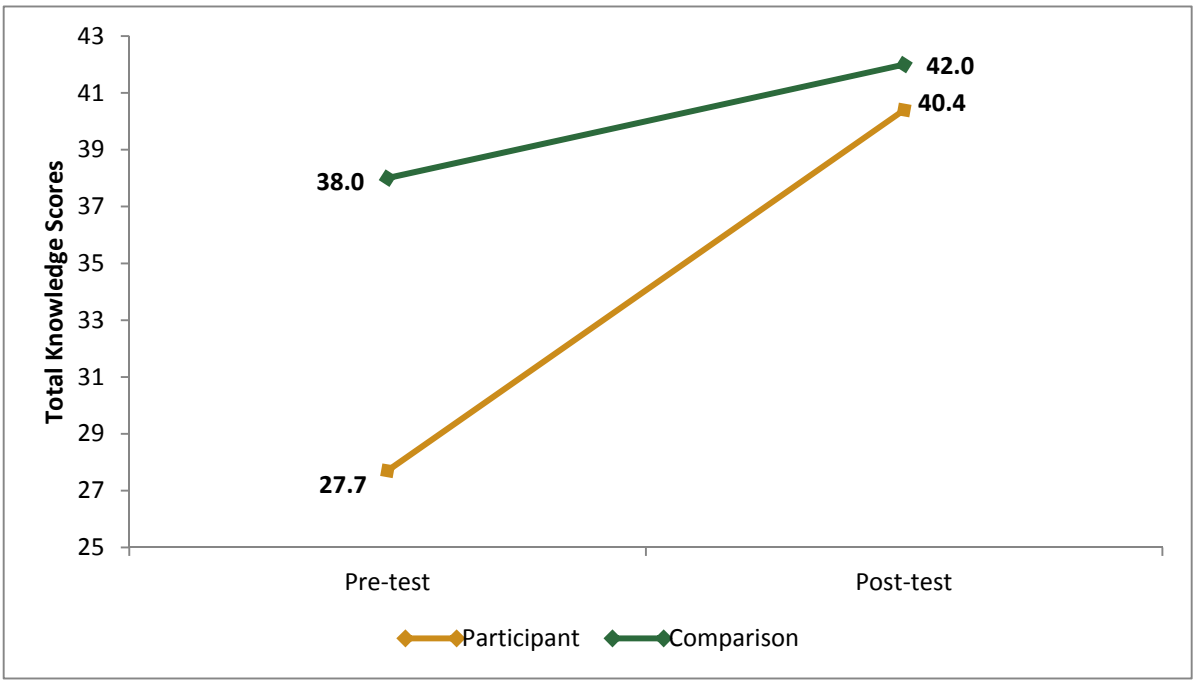
*Significant at the 0.05 level

Exhibit TO21. Middle School Two Year Mathematics LMT: Pre-Post Total Knowledge Change Score Comparison, 2012-2014 Teacher Outcomes Report

Total Knowledge LMT Change Score (Post Score- Pre Score)	Mathematics Middle School	
	Participant Teachers (N=40)	Comparison Teachers (N=27)
Minimum change	-9.0	-8.0
Maximum change	32.0	28.0
Median change	11.5	2.0
Mean change	12.8	3.8
Standard deviation of change	9.1	7.8
Between Group t-test	t=4.181*, <.001	

*Significant at the 0.05 level

Exhibit TO22. Middle School Two Year Mathematics LMT: Pre-Post Mean Total Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Number Concepts and Operations

At pre-test, a significant difference was observed between teacher groups on the LMT Number Concepts and Operations sub-section (t=-2.450, 0.017). At post-test, middle school math participant teachers did not differ from comparison teachers on average (t=-.340, p=.735, p=0.034).

When comparing within teacher group, participant teachers average score significantly increased from pre (7.1) to post (9.5) (t=5.264, p<0.001), as evidenced by a mean change score of 2.5 (see Exhibit TO23). No significant change was observed from pre to post for comparison teachers. Participant teachers did not differ from comparison teachers in terms of average change from pre-post (Exhibit TO 24). Exhibit TO25 graphs the average pre-post test results for each group.

Exhibit TO23. Middle School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Knowledge Change Score Comparison, 2012-2014Teacher Outcomes Report

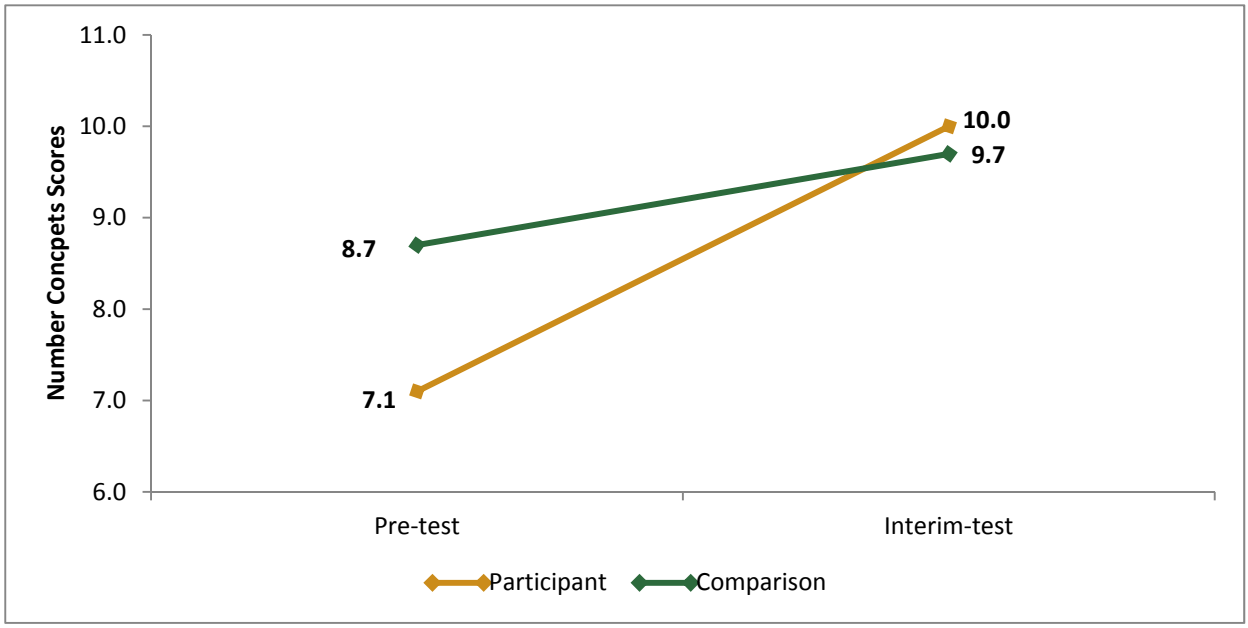
LMT Number Concepts and Operations: Pre-Post Knowledge Score	Mathematics Middle School			
	Participant Teachers (N=40)		Comparison Teachers (N=27)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0	3.0	4.0	3.0
Maximum score	11.0	14.0	15.0	17.0
Median score	7.0	10.0	8.0	10.0
Mean score	7.1	9.5	8.7	9.741
Standard deviation	2.6	2.4	2.9	3.4
Within group Pre-Post t-test	t=5.264*,p=<.001		t=1.840, p= .077	

*Significant at the 0.05 level

Exhibit TO24. Middle School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Number Concepts and Operations: Change Score (Post Score- Pre Score)	Mathematics Middle School	
	Participant Teachers (N=40)	Comparison Teachers (N=27)
Minimum change	-3.0	-4.0
Maximum change	12.0	7.0
Median change	2.0	1.0
Mean change	2.5	1.0
Standard deviation of change	2.9	2.9
Between Group t-test	t=1.931, p=.058	

Exhibit TO25. Middle School Two Year Mathematics LMT Number Concepts and Operations: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Geometry

Exhibits TO26 through TO28 show that middle school mathematics participant differed significantly from comparison teachers for LMT Geometry Knowledge pre-tests (t=-3.601, p=.001). However at the post-test the two groups did not have any statistically significant differences in average test scores (t=.317, p=-.752). Both groups significantly improved when comparing their pre-test scores to post-test scores (Exhibit TO26). The participant group had statistically greater changes in their scores from pre to post-test (Exhibit TO27). Exhibit TO28 illustrates these findings by displaying a line graph of average pre and post-test scores for each group.

Exhibit TO26. Middle School Two Year Mathematics LMT Geometry: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Geometry: Pre-Post Knowledge Score	Mathematics Middle School			
	Participant Teachers (N=40)		Comparison Teachers (N=27)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	0	9.0	0	5.0
Maximum score	17.0	24.0	19.0	19.0
Median score	9.0	15.0	13.0	15.0
Mean score	8.3	14.9	12.6	14.6
Standard deviation	4.4	2.8	5.3	3.5
Within group Pre-Post t-test	t=9.511*,p=<.001		t=2.675*, p= .013	

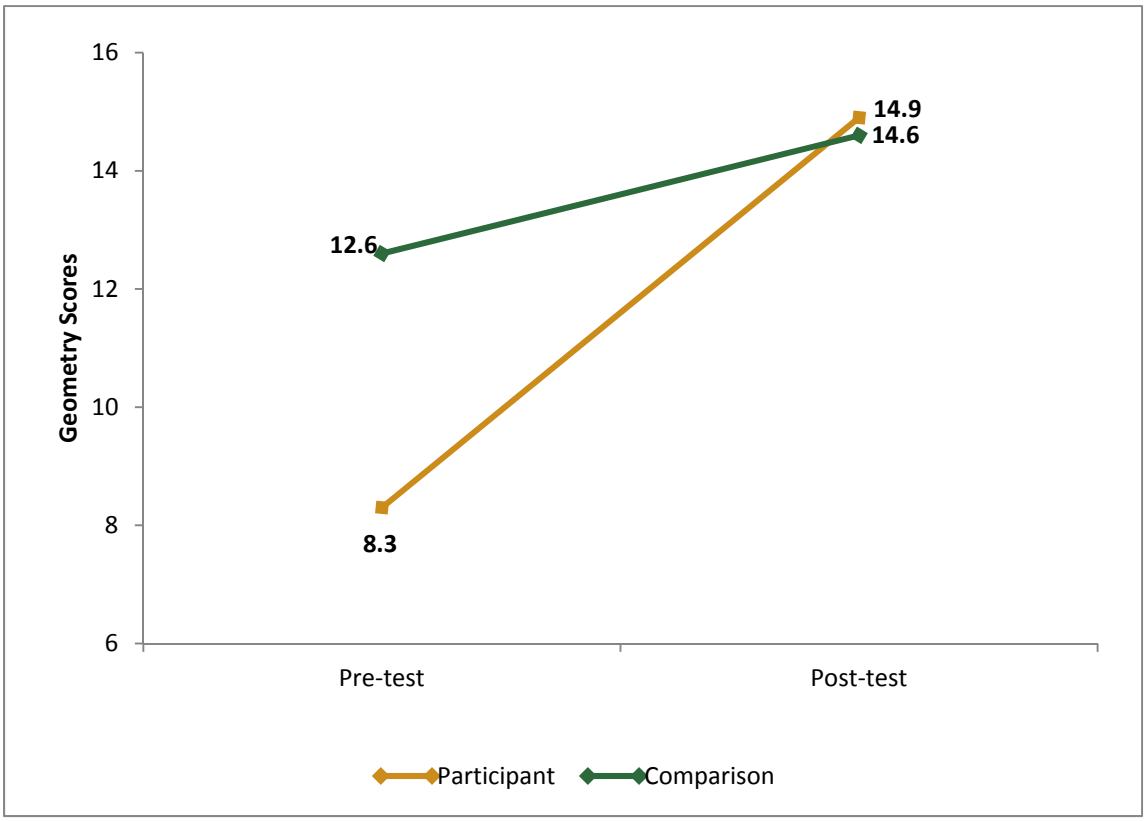
*Significant at the 0.05 level

Exhibit TO27. Middle School Two Year Mathematics LMT Geometry: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Geometry Knowledge Change Score (Post Score- Pre Score)	Mathematics Middle School	
	Participant Teachers (N=40)	Comparison Teachers (N=27)
Minimum change	-5.0	-8.0
Maximum change	16.0	16.0
Median change	4.0	1.0
Mean change	3.9	0.80
Standard deviation of change	3.8	3.2
Between Group t-test	t=4.314*, p=<.001	

*Significant at the 0.05 level

Exhibit TO28. Middle School Two Year Mathematics LMT Geometry: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



LMT – Patterns, Functions, and Algebra

As with the geometry sub-section, the middle school Mathematics participant and comparison teachers differed significantly at pre-test (t=2.775, p=.007) on the LMT – Patterns, Functions, and Algebra sub-section. At the post-test the groups did not differ (t=.452, p=.653). By individual group, however, the participant group significantly improved where the comparison teacher group did not (t=2.852, p=.006; Exhibit TO29). The difference in change scores between the two teacher groups was statistically significant (Exhibit TO30). Exhibit TO31 graphs the average pre and post test scores for this sub-section, by group.

Exhibit TO29. Middle School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Score	Mathematics Middle School			
	Participant Teachers (N=40)		Comparison Teachers (N=27)	
	Pre-test	Post-test	Pre-test	Post-test
Minimum score	3.0	8.0	5.0	7.0
Maximum score	23.0	25.0	27.0	28.0
Median score	12.0	16.0	16.0	16.0
Mean score	12.3	16.1	15.9	16.6
Standard deviation	4.3	4.2	6.2	5.6
Within group Pre-Post t-test	t=4.995*, p=<.001		t=3.762, p=.264	

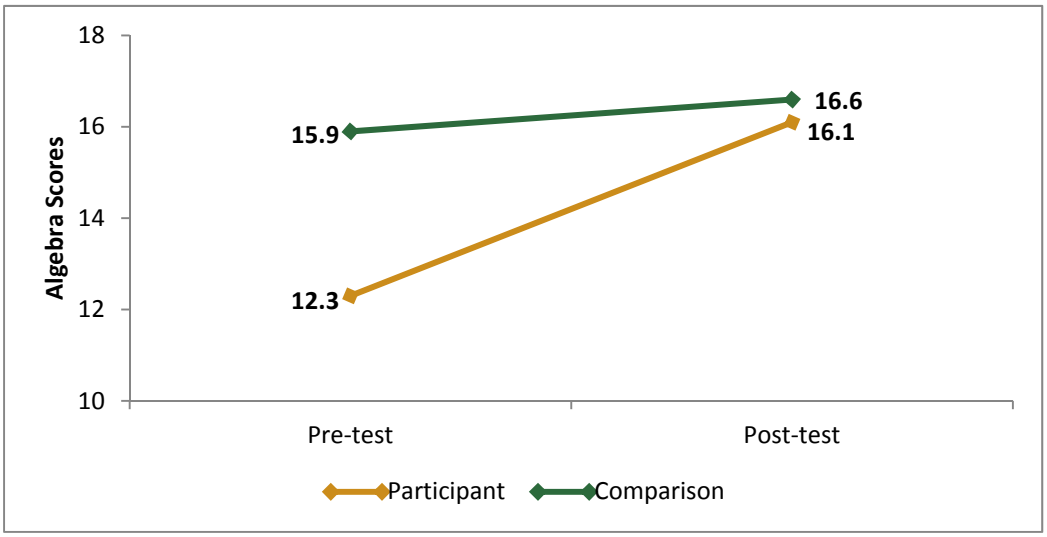
*Significant at the 0.05 level

Exhibit TO30. Middle School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report

LMT Patterns, Functions, and Algebra: Change Score (Post Score- Pre Score)	Mathematics Middle School	
	Participant Teachers (N=40)	Comparison Teachers (N=27)
Minimum change	-7.0	-5.0
Maximum change	15.0	9.0
Median change	4.0	1.0
Mean change	3.8	0.74
Standard deviation of change	4.8	3.4
Between group t-test	t=2.852*, p=.006	

*Significant at the 0.05 level

Exhibit TO31. Middle School Two Year Mathematics LMT Patterns, Functions, and Algebra: Pre-Post Mean Knowledge Score Comparison, 2012-2014 Teacher Outcomes Report



MSP Mathematics Projects Teacher Outcomes Discussion

Overall, the Intel Math curriculum used in the MSP Mathematics projects' professional development has led to improvements in content knowledge for teachers at both the elementary and middle school levels.

One year elementary IMC scores had a mean score increase of 12.2% for participant teachers, a statistically significant increase for that group. Though matched initially matched on demographics, comparison teachers regularly outperformed participant teachers on pre-tests. These differences were lost due to participant teachers' significant gains at post-test, yielding them comparable scores to the comparison group. However, this percent increase by participant teachers was not significantly different than comparison teachers' 9.0% score increase over that same time period. These findings indicate participant teachers showed gains from program participation while comparison teachers' scores stayed flat.

Two year elementary IMC scores showed no comparable differences between participant teachers or comparison teachers at pre-test. However, by two year post-test, the mean increase in participant teachers' scores of 11.7% was significantly higher than the comparison teachers' score of 1.7%. A closer look at changes in scores between the pre and interim-test and the interim and post-test pairs showed the participant teachers made significant gains both years of the program. The comparison teachers showed no significant gains either year of the two year program.

Two year elementary LMT participant teacher pre-test scores were significantly lower than comparison teachers in total knowledge and the subtests of number concepts and algebra. However, by post-test participant teacher scores were not statistically different than comparison teachers. Participant teachers made significant gains in total knowledge and all three subtests over the two year project, increasing the average total knowledge score by 10.9 points. Comparison teachers also made significant gains in total knowledge and the sub-tests of number concepts and geometry. This may indicate factors outside of the math project were influential in teacher gains.

One year middle school IMC pre-post testing data was very small, with only five participant teachers and seven comparison teachers. Given these sample sizes, nonparametric statistical tests were used to determine whether the distribution of scores at pre-test and post-test varied between groups. Mann-Whitney U test findings indicate no significant differences between the two groups. However, given the small sample size it would be inappropriate to generalize these findings to the larger middle school teacher population.

Two year middle school IMC data showed no comparable difference between participant teachers and comparison teacher average scores at pre-test. Interestingly, both groups made significant gains from pre to post-test, including significant gains both the first and second year of the math program. When examining gains between years it is important to note that significant gains were made the first year of the project by both groups, however, for the second year no significant gains were made by either group. Participant teacher gains were significantly greater than comparison teacher gains at post-test, with a mean average increase of 10.8% vs. 6.0%.

Two year middle school LMT participant teachers showed significant gains in LMT scores on total knowledge and the three sub-sections of number concepts, geometry, and algebra; while comparison teachers showed significant gains only in total knowledge and the sub-section of geometry. When examining each section individually, we found participant teachers scored significantly lower than comparison teachers on all pre-tests. However in each case at post-test the participant teachers made significant gains that brought them to average scores that did not differ significantly from comparison groups at post-test. Comparison scores stayed relatively flat through the two year math project, with the exception of knowledge total score and geometry which increased significantly.

Science Projects Teacher Outcomes Data

Since all participants in the Science Projects take the same version of the DTAMS, data for teachers of all grade levels is presented together. For the current assessment period, all teachers participated in the Physical Science curriculum. This report covers the pre content knowledge assessments and post content knowledge assessments collected by sites during the 2013-2014 project year.

The four areas of this section of the report include:

1. An overview of participant and comparison teacher groups;
2. Demographic data comparing the characteristics of both teacher groups;
3. An analysis of DTAMS pre-test and post-test data; and
4. A summary of DTAMS data analysis.

There were four MSP Science Projects during the 2013– 2014 funding cycle:

- Northern Arizona Environmental Science and Literacy Integration Project (NZASLI) – Coconino County Education Service Agency
- Powerful Engineering & Physical Science Ideas (PEPSI) – Gilbert Public Schools
- Mesa, Tempe & Casa Grande MSP Project PASS (Partnership Access for Student Success) – Mesa Public Schools
- Teaching in Physical Science (TIPS) – Parker Unified School District

Science Participant and Comparison Teacher Overview

There were a total of 274 participant teachers and 220 comparison teachers recruited across the five Science Projects. Pre content knowledge assessments were completed by 252 participant and 200 control teachers (Exhibit TO32). Post content knowledge assessments were completed by 169 participant and 131 control teacher.

Exhibit TO32. Teachers Assessed, 2013-2014 MSP Projects

Participant Teachers (274 Recruited)	Comparison Teachers (220 Recruited)	Total (494 Recruited)
169 (62%)	131 (60%)	300 (61%)

Participant and Comparison Teacher Demographics

Key demographic and teaching-related characteristics that are used by the Science programs as potential matching variables are shown in Exhibit TO33. Among participants with data, overall the participant and comparison teachers were comparable on gender, years of teaching experience, number of science courses taken, and grade level currently taught.

Exhibit TO33. Teacher Characteristics for MSP Science Participant and Comparison Teachers, 2013-2014 Teacher Outcomes Report

Characteristic	Participant Teachers	Comparison Teachers
Gender		
Female	149 (88.2%)	114 (87.0%)
Male	14 (8.3%)	14 (10.7%)
Unknown	6 (3.6%)	3 (2.3%)
Years Teaching		
<5 years	24 (14.2%)	16 (12.2%)
5-10 years	44 (26.0%)	49 (37.4%)
11-20 years	75 (44.4%)	43 (32.8%)
21+ years	23 (13.6%)	20 (15.3%)
Unknown	3 (1.8%)	3 (2.3%)
Grade Teaching		
K-3	75 (44.4%)	58 (44.3%)
4-5	40 (23.7%)	34 (26.0%)
6-8	6 (3.6%)	1 (0.8%)
9-12	35 (20.7%)	31 (23.7%)
Other/Unknown	13 (7.7%)	7 (5.3%)
Number of Science Courses		
0	24 (14.2%)	16 (12.2%)
1-3	45 (26.6%)	31 (23.7%)
4-5	15 (8.9%)	19 (14.5%)
6 or more	77 (45.6%)	59 (45.0%)
Other/Unknown	8 (4.7%)	6 (4.6%)

Diagnostic Teacher Assessments in Mathematics and Science (DTAMS)

The following section assesses teacher outcomes for the Physical Science DTAMS assessment. Each section provides content knowledge score analyses for the participant and comparison teachers. Throughout this report, scores were analyzed by an independent sample t-test to test for significant differences in scores across teacher groups. Numbers analyzed may vary depending on the completeness of the data.

There are three types of scores for the DTAMS assessment: The Total Knowledge score, the Content Subcategory score, and the Science, Technology, and Society (STS) score. The Total Knowledge score has a maximum value of 35 and includes both the Content Subcategory score (with a maximum value of 25) and a Pedagogy score (with a maximum value of 10). The STS score is a separate construct focused on the interactions of science with technology and human society and has a maximum value of 5 points.

DTAMS Physical Science

All four MSP Science projects focused on Physical Science for their professional development curriculum.

Total Knowledge Score

There were no significant differences between participant teachers and control teachers on the Total Knowledge pre-test (Exhibit TO34). Participant teachers scored significantly higher than comparison teachers on the Content post-test (Exhibit TO35).

Exhibit TO34. Pre Total Knowledge Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Pre Knowledge Scores (35 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	4	2
Maximum score	30	26
Median score	12.00	13.00
Mean score	12.58	13.00
Standard deviation	5.279	4.978
Between Group t-test	t= .701, p=.484	

Exhibit TO35. Post Total Knowledge Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Post Knowledge Scores (35 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	4	2
Maximum score	31	26
Median score	14.00	12.61
Mean score	14.29	12.00
Standard deviation	5.293	4.818
Between Group t-test	-2.834, p=.005*	

*Significant at the 0.05 level

Content Score

There were no significant differences between participant teachers and control teachers on the Content pre-test (Exhibit TO36). Participant teachers scored significantly higher than comparison teachers on the Content post-test (t=2.917, p=.004; Exhibit TO37).

Exhibit TO36. Pre Content Subcategory Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report.

Pre Content Scores (25 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	4	1
Maximum score	23	21
Median score	11.00	12.00
Mean score	11.60	11.82
Standard deviation	4.240	39.45
Between Group t-test	t= .445, p=.656	

Exhibit TO37. Post Content Subcategory Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report.

Post Content Scores (25 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	4	2
Maximum score	23	21
Median score	13.00	11.00
Mean score	12.67	11.40
Standard deviation	3.773	3.658
Between Group t-test	t=2.917, p=.004*	

*Significant at the 0.05 level

Pedagogy Score

There were no significant differences between participant teachers and control teachers on the Pedagogy pre-test (Exhibit TO38). Participant teachers scored significantly higher than comparison teachers on the Pedagogy post-test (t=1.986, p=.048; Exhibit TO39).

Exhibit TO38. Pre Pedagogy Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Pre Pedagogy Scores (10 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	0	0
Maximum score	7	6
Median score	.00	1.00
Mean score	.98	1.18
Standard deviation	1.480	1.508
Between Group t-test	t=1.191, p=.235	

Exhibit TO39. Post Pedagogy Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Post Pedagogy Scores (10 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	0	0
Maximum score	8	8
Median score	1.00	1.00
Mean score	1.62	1.21
Standard deviation	1.918	1.625
Between Group t-test	t=1.986, p=.048*	

*Significant at the 0.05 level

STS Score

There were no significant differences between participant teachers and control teachers on the Pre STS scores (Exhibit TO40) or the Post STS scores (Exhibit TO41).

Exhibit TO40. Pre STS Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Pre STS Scores (5 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=131)
Minimum score	0	0
Maximum score	5	4
Median score	2.00	2.00
Mean score	2.37	2.37
Standard deviation	1.257	1.077
Between Group t-test	t=.052, p=.958	

Exhibit TO41. Post STS Score Comparison for Physical Science, 2013-2014 Teacher Outcomes Report

Post STS Scores (5 possible)	DTAMS Physical Sciences	
	Participant Teachers (N=169)	Comparison Teachers (N=99)
Minimum score	0	0
Maximum score	5	4
Median score	3.00	3.00
Mean score	2.72	2.46
Standard deviation	1.155	1.043
Between Group t-test	t=-1.823, p=.069	

DTAMS Science Discussion

There were no significant differences between participant and comparison teachers with respect to gender, years of teaching experience, number of science courses taken, and grade level currently taught, indicating that subjects were well matched on these criteria. In addition, there were no significant differences between participant and comparison teachers in the pre physical science assessments. Posttests revealed significant gains for participant teachers in knowledge, content, and pedagogy subcategories that resulted in them scoring significantly higher than comparison teachers at post-test. It is interesting to note no significant gains were made by either teacher group on the STS, as both scores stayed relatively flat over the project years.

Classroom Observations: Reformed Teaching Observation Protocol (RTOP) Scores

The Reformed Teaching Observation Protocol (RTOP) data were collected within each MSP project to with the goal of determining changes in teachers' classroom practice over the course of the professional development program. The total scores is the sum of several RTOP sub-categories including:

- Lesson Design;
- Propositional Knowledge;
- Procedural Knowledge;
- Communicative Interactions; and
- Student Teacher Relationships.
- This report covers the pre-test assessments and post-test assessments collected by sites at project start and end.

Mathematics Projects

Independent sample t-test showed that one year math comparison teachers had higher average scores than comparison teachers on the sub-category of propositional knowledge while the comparison teachers scored significantly higher on lesson design (Exhibit TO42).

Exhibit TO42. Average Pre-test scores and t-test results on Mathematics One Year RTOP Scores, 2013-2014 Teacher Outcomes Report

Pre-test Scores	Points Possible	Participant Teachers (N = 97) mean (SD)	Comparison Teachers (N = 97) mean (SD)	*P*-value*
Total RTOP	100	22.95 (13.90)	23.34 (13.91)	.845
Lesson Design	20	3.95 (2.40)	4.78 (2.73)	.025**
Propositional Knowledge	20	6.08 (3.62)	5.00 (3.05)	.025**
Procedural Knowledge	20	3.96 (3.13)	4.47 (2.87)	.233
Communicative Interactions	20	4.07 (2.93)	4.44 (3.07)	.391
Student Teacher Relationships	20	4.89 (3.30)	4.64 (3.60)	.618

*From independent sample t-test.

Independent sample t-test showed that two year math participant teachers and comparison teachers had comparable pre-test scores on the Total RTOP and all sub-categories.

Exhibit TO43. Average Pre-test scores and t-test results on Mathematics Two Year RTOP Scores, 2012-2014 Teacher Outcomes Report

Pre-test Scores	Points Possible	Participant Teachers (N = 83) mean (SD)	Comparison Teachers (N = 57) mean (SD)	*P*-value*
Total RTOP	100	30.81 (21.60)	33.58 (21.90)	.459
Lesson Design	20	5.47 (4.52)	6.44 (5.24)	.245
Propositional Knowledge	20	7.52 (4.77)	7.58 (4.66)	.940
Procedural Knowledge	20	5.33 (4.19)	5.47 (5.14)	.851
Communicative Interactions	20	5.47 (4.39)	6.70 (4.40)	.106
Student Teacher Relationships	20	7.02 (5.00)	7.39 (4.62)	.665

*From independent sample t-test.

**Significant at the 0.05 level

Independent sample t-test showed that year one math project participant teachers had significantly higher scores than comparison teachers at post-test on the Total RTOP and all sub-categories (Exhibit TO44).

Exhibit TO44. Average Post-test scores and t-test results on Mathematics Year 1 RTOP Scores, 2013-2014 Teacher Outcomes Report

Post-test Scores	Points Possible	Participant Teachers (N = 97) mean (SD)	Comparison Teachers (N = 97) mean (SD)	*P*-value*
Total RTOP	100	63.03 (29.34)	29.81 (19.12)	< .001**
Lesson Design	20	12.07 (6.10)	5.29 (3.77)	< .001**
Propositional Knowledge	20	13.88 (6.01)	7.80 (4.05)	< .001**
Procedural Knowledge	20	12.43 (6.52)	4.67 (3.86)	< .001**
Communicative Interactions	20	11.66 (5.90)	5.02 (4.00)	< .001**
Student Teacher Relationships	20	12.99 (5.79)	7.03 (5.12)	< .001**

*From independent sample t-test.
**Significant at the 0.05 level

There were no significant differences between participant teachers and comparison teachers on the average post-test scores (Exhibit TO45).

Exhibit TO45. Average Post-test scores and t-test results on Mathematics Year 2 RTOP Scores, 2013-2014 Teacher Outcomes Report

Pre-test Scores	Points Possible	Participant Teachers (N = 83) mean (SD)	Comparison Teachers (N = 57) mean (SD)	*P*-value*
Total RTOP	100	36.89 (21.79)	33.53 (20.149)	.356
Lesson Design	20	7.02 (4.99)	5.98 (4.92)	.225
Propositional Knowledge	20	8.29 (4.12)	8.42 (2.75)	.848
Procedural Knowledge	20	5.92 (4.49)	5.35 (4.27)	.457
Communicative Interactions	20	6.90 (4.98)	6.12 (4.52)	.346
Student Teacher Relationships	20	9.18 (5.93)	7.65 (4.79)	.107

*From independent sample t-test.

The average change for participant teachers when compared to comparison teachers from the pretest to Year 1 posttest was significantly higher for total RTOP score and all subtests (Exhibit TO46).

Exhibit TO46. Average Change Pre-Post Scores for Participant Teachers from Mathematics Year 1 RTOP Scores, 2013-2014 Teacher Outcomes Report

Average Difference	t	*P*-value
Total RTOP	10.09	< .001*
Lesson Design	11.82	< .001*
Propositional Knowledge	7.08	< .001*
Procedural Knowledge	11.09	< .001*
Communicative Interactions	9.71	< .001*
Student Teacher Relationships	7.16	< .001*

*Significant at .05 level

The average change for participant teachers when compared to comparison teachers from the pretest to Year 2 posttest was significantly higher for lesson design and communicative interactions (Exhibit TO47).

Exhibit TO47. Average Change in Pre-Post Scores for Participant Teachers from Mathematics Year 2 RTOP Scores, 2013-2014 Teacher Outcomes Report

Average	t	*P*-value
Total RTOP	1.390	.167
Lesson Design	2.063	.041*
Propositional Knowledge	-.077	.939
Procedural Knowledge	.744	.458
Communicative Interactions	.509	.037*
Student Teacher Relationships	1.642	.087

*Significant at .05 level

Science Projects

Participant teachers scored slightly lower, on average, than comparison teachers on the Total RTOP and each of its sub-categories. However, only the difference in student-teacher relationships was statistically significant (Exhibit TO48).

Exhibit TO48. Average Pre-test scores and t-test results on Science RTOP Scores, 2013-2014 Teacher Outcomes Report

Pre-test Scores	Points Possible	Participant Teachers (N = 167) mean (SD)	Comparison Teachers (N=127) mean (SD)	*P*-value*
Total RTOP	100	25.22 (19.50)	28.90 (22.76)	.138
Lesson Design	20	4.38 (4.09)	5.19 (4.79)	.121
Propositional Knowledge	20	6.25 (4.38)	6.68 (4.88)	.426
Procedural Knowledge	20	4.13 (3.81)	4.66 (4.40)	.265
Communicative Interactions	20	4.91 (4.05)	5.58 (4.29)	.171
Student Teacher Relationships	20	5.56 (4.60)	6.79 (5.78)	.043**

*From independent sample t-test.

**Significant at the 0.05 level

Participant teachers scored significantly higher than comparison teachers on the posttest RTOP scores on total RTOP and subcategories (Exhibit TO49).

Exhibit TO49. Average Post-test scores and t-test results on Science RTOP Scores, 2013-2014 Teacher Outcomes Report

Post-test Scores	Points Possible	Participant Teachers (N = 167) mean (SD)	Comparison Teachers (N=127) mean (SD)	*P*-value*
Total RTOP	100	44.62 (22.61)	36.76 (21.09)	.003**
Lesson Design	20	8.08 (4.74)	6.69 (4.67)	.013**
Propositional Knowledge	20	9.87 (5.23)	8.60 (4.56)	.030**
Procedural Knowledge	20	8.05 (4.49)	6.38 (4.57)	.002**
Communicative Interactions	20	8.62 (4.52)	7.33 (4.22)	.013**
Student Teacher Relationships	20	9.50 (5.09)	7.77 (5.04)	.004**

*From independent sample t-test.

**Significant at the 0.05 level

RTOP Discussion

At pre-observation of the RTOP the one year Mathematics projects had some significant differences between the participant and comparison group teachers in lesson design and propositional knowledge. At post-test, the comparison group scored significantly higher than the comparison group on all categories. Year two Mathematics projects' groups were comparable at pre-test and significant gains were made by participant teachers in lesson design and communicative interactions.

Science RTOP teacher groups differed significantly at pre-test in the area of student teacher relationships, with comparison teachers showing higher average scores. However, at post-test these differences were erased by the significant gains the participant teachers made, as they scored significantly higher for every category than the comparison teacher group.

Teacher Outcomes Overall Summary

Both the Mathematics and Science MSP projects in 2012 – 2014 had adequate equivalence in demographics between the participant and comparison teachers, with the exception of gender equivalence in one year middle school math projects due to attrition at post-test. This indicates that the groups are generally well matched in terms of demographics. There were however differences between the participant and comparison teachers test scores at the initial pre-tests. For both the elementary school Mathematics projects and the Science projects the LMT and DTAMS had differences between the participant and comparison teacher groups at pre-test. The Mathematics projects also had significantly higher RTOP pretest scores for propositional knowledge in participant teachers.

The one year Mathematics projects had 63 total participant group teachers and 66 total comparison group teachers with matched pre-post assessments. One area of note is that the middle school teachers for the one year Mathematics projects had small numbers of recruited teachers and smaller numbers of teachers who completed both pre and post assessments. This small sample size limited the statistical analysis available and limits the ability to draw conclusions from the middle school Mathematics project assessments. The two year Mathematics projects had 149 total participant group teachers and 145 total comparison group teachers with matched pre-post assessments. The Science projects had 169 total participant group teachers and 131 total comparison group teachers with matched pre-post assessments. Overall the groups maintained their demographic equivalence.

In their first year post-test, mathematics and science teachers increased their RTOP scores significantly for lesson design, procedural knowledge, communicative interactions, and student-teacher relationships. However, for two-year math RTOP assessments, scores decreased from year one gains and were not significantly higher than comparison teachers.

Overall, both the Mathematics projects' and Science projects' participant teachers, improved in their content knowledge as measured by the Intel Math Content Assessment (IMC), the Learning Mathematics for Teaching (LMT) assessment, and the Diagnostic Teacher Assessments in Mathematics (DTAMS). Participant teachers also demonstrated significant gains in mathematics and science RTOP scores over first year of the project time period.