OREGON MATHEMATICS LEADERSHIP INSTITUTE PROJECT: EVALUATION RESULTS ON TEACHER CONTENT KNOWLEDGE, IMPLEMENTATION FIDELITY, AND STUDENT ACHIEVEMENT

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Abstract

The Oregon Mathematics Leadership Institute (OMLI) National Science Foundation Mathematics and Science Partnership project partners are Oregon State University, Portland State University, Teachers Development Group, and ten Oregon school districts. The primary activities of the project were a sequence of three intensive three-week residential institutes emphasizing mathematics content knowledge for teaching, collegial leadership, and the building of Professional Learning Communities. Teachers at all levels of grades K-12 participated together in the mathematics content courses. By the conclusion of the third Summer Institute, teachers had shown significant improvements in mathematical content knowledge for teaching. Analysis of student achievement data in participating schools was initially inconclusive. However, once implementation fidelity traits were taken into account, a positive relationship between project participation and student achievement emerged. The degree to which schools implement the practices promoted by the OMLI project is a significant positive predictor of student performance above and beyond what can be explained by the socioeconomic factor as indicated by the percentage of students who qualify for the free and reduced lunch program. This relationship is particularly acute at secondary levels, but additional factors appear to be at play at elementary grade levels.

Introduction

The Oregon Mathematics Leadership Institute (OMLI) is a five-year project funded by the National Science Foundation under the Mathematics and Science Partnership program with additional federal funding provided through the Oregon Department of Education. The OMLI is a partnership between Oregon State University, Portland State University, Teachers Development Group, and ten Oregon school districts: Beaverton, Bend-LaPine, Crook County, Molalla River, North Clackamas, Redmond, Reynolds, Roseburg, South Lane, and Woodburn. These school districts include both rural and urban settings, a wide range of socio-economic student backgrounds, and one district with a majority of students classified as English Language Learners

(ELL). Some of the partner school districts themselves have provided additional funding to expand participation in the OMLI project.

The unit of participation in OMLI is a School Leadership Team, ideally consisting of two teachers and one school administrator, usually the principal of the school. The project has approximately 180 teachers (90 from grades K-5, 60 from middle school grades 6-8, and 30 from high school grades 9-12) and 95 administrators participating across the ten partner districts. The Oregon Mathematics Leadership Institute (OMLI) works to build collaborative Professional Learning Communities within the participating schools through a series of intensive summer institutes and academic year follow-up professional development activities for teams of teachers and administrators.

Participating teachers attended three, 3-week residential Summer Institutes during three consecutive summers (2005, 2006, and 2007). The participating administrators attended the third week of each of the three Summer Institutes. These Summer Institutes included mathematics content coursework across six strands: numbers and operations, algebraic structures, measure and change, geometry, data analysis and probability, and discrete mathematics. The mathematics content coursework was complemented by leadership development coursework.

Academic year activities facilitated the ongoing development of collaborative Professional Learning Communities (PLC's) within each participating school. These activities will continue at least through the 2008-09 academic year, and are intended to promote and sustain systemic mathematics reform to increase student achievement in mathematics.

Description of the OMLI Summer Institutes

Participants were housed on the Oregon State University campus and Institute classes were held in a middle school near the campus. The typical schedule for the Institute involved teachers attending two, 2-hour mathematics classes in the morning with a two-hour study session and a two-hour Collegial Leadership workshop in the afternoon. Approximately sixty teachers each were enrolled in a "triad" of courses consisting of a pair of mathematics courses and the Collegial Leadership workshop. Hence, all 180 teachers would have participated in all six mathematics content strands and three Collegial Leadership workshops by the conclusion of the third Summer Institute in Summer 2007. The six mathematics content strands are paired as follows: 1) *Numbers and Operations* and *Geometry*; 2) *Data and Chance* and *Discrete Mathematics*; 3) *Algebraic Structures* and *Measurement and Change*.

Using the Conference Board of the Mathematical Sciences recommendations for the preparation of teachers, OMLI mathematics instructors chose depth in a few "big idea" topics rather than attempting to address many topics [1]. In each content course, there was an explicit emphasis on student discourse and faculty were expected to model many of the pedagogical techniques used in K-12 classrooms that are the focus of the Collegial Leadership workshops in the afternoons.

During one of the afternoon periods, teachers participated in a facilitated "study hall" with mathematics content faculty available for assistance. During the other period, teachers participated in a Collegial Leadership workshop facilitated by staff from the Teachers Development Group. Approximately ninety teachers participated in study hall in the first afternoon session while the other ninety teachers participated in the Collegial Leadership workshops. During the second afternoon period, these two groups of teachers switched. In the third week of the Summer Institute, participating principals attended Collegial Leadership workshops in the morning while teachers were attending mathematics content classes. During the afternoons of the third week, principals had opportunities to work together in a team with the teachers from their schools to develop school action plans for professional development during the upcoming academic year.

A unique feature of the OMLI Institutes was that teachers from all K-12 grades participated together in the mathematics content courses. This was a conscious choice made to stimulate interaction among teachers from elementary, middle, and high schools in the same district and to give all teachers a better sense of the "trajectory" of a mathematical idea across the entire K-12 curriculum. To be sure, this choice placed unusual challenges on our mathematics content faculty. The OMLI mathematics content courses included explorations and tasks that could be approached at several levels of sophistication. This allowed all teachers in the course to initially engage together in an activity while still affording opportunities for teachers with different backgrounds to employ their existing knowledge bases. The use of new or unfamiliar mathematical settings also served to "level the playing field," in the sense that tasks were provided that teachers at all levels could approach as fresh.

For example, *Geometry* focused on some non-Euclidean models for spherical geometry and the taxicab metric to foster insights into Euclidean geometrical properties. *Data and Chance* made extensive use of the software *TinkerPlots*™, something new to virtually all of the teachers. *Algebraic Structures* used a case study of a third grader's conjecture to launch a far reaching investigation that ultimately involved elements of group theory. *Measure and Change* included extensive activities with non-standard units. The *Numbers and Operations* course examined connections to harmonics in music. Not surprisingly, many of the topics of *Discrete Mathematics* were new to most of the teachers at all grade levels.

During Collegial Leadership workshop activities, the Collegial Leadership team draws heavily on the latest nationally recognized, evidence-based mathematics professional development and leadership development resources, such as: *Designing Professional Development for Teachers of Science and Mathematics*; *Learning and Teaching Linear Functions: Video Cases for Mathematics Professional Development, 6-10*; *Learning to Lead Mathematics Professional Development*; *Fostering Algebraic Thinking: A Guide for Teachers, Grades 6-10*; *Developing Mathematical Ideas*; *Children's Mathematics: Cognitively Guided Instruction*; and, *Lenses on Learning* [2-8]. Team members modeled and emphasized "best" instructional practices and curricula based on the NCTM's *Professional Standards for Teaching Mathematics*, and provided extensive instruction and mentoring to School Leadership Teams for effective job-embedded, practice-based professional learning (e.g., lesson study, protocol-based collegial observations and examinations of student work, case discussions and development, book studies, etc.) [9].

Description of the OMLI Site Visits

Site visits to participating OMLI schools involved a minimum of a half-day site visit per school, with four site visits each year per school. These site visits are designed to meet the following goals:

1) Support School Leadership Teams for implementation of their Collegial Leadership Action Plans, which were crafted by the teams during the 2007 Summer Institute to initiate and sustain school-based collaborative Professional Learning Communities that center on mathematics content, learning, teaching, and leadership; and,
2) Support continued learning by the OMLI participants and their school colleagues through first-hand experiences with practice-based professional learning facilitated by OMLI faculty.

While a major focus of work in the schools centered around deepening the quality of mathematical discourse in classrooms through collaborative lesson planning, observation, and reflection about lessons, the following are other specific site visit activities designed to support learning for effective lesson design and implementation:

- Data snaps (classroom walk-throughs) to gather data as context for professional dialogue and making inferences regarding what typifies mathematical discourse across the school;
- Case discussions (video and print);
- Extended classroom observations and inference dialogue based on Teachers Development Group's Student Discourse Observation Protocol and Collaborative Lesson Planning Protocol (designed to support teachers in moving classroom discourse along a continuum from a focus on procedures and facts to a focus on justification and generalization);
- Consultation regarding implementation of school mathematics curriculum materials;
- Co-facilitation (with OMLI participants) of school-based professional development and district meetings;
- Coaching OMLI participants in leading the district site visit meetings; and,
- Facilitating and/or coaching the facilitation of the examination of student work by OMLI participants and/or their building colleagues.

In addition to site visits, OMLI site visit faculty members facilitate four half-day district meetings throughout the academic year in each district. During these meetings, all participating OMLI teachers and administrators from a district come together to share their successes and challenges, to plan for districtwide expansion of OMLI, and to continue learning together by examining student work, discussing professional readings, planning collaborative lessons, and analyzing and enhancing mathematical tasks, as well as other activities such as those in the list above.

District Leadership Teams worked with Collegial Leadership/Site Visit Support Teams to identify specific needs and to coordinate site visits. The District Leadership Teams conducted regular meetings during the academic year with the School Leadership Teams. School Leadership Teams (SLT) were expected to actively increase the quantity and quality of school-based collegial inquiry and discourse about mathematical and pedagogical content by planning and facilitating regular academic year meetings of building colleagues, and using and facilitating practice-based professional development activities, such as classroom observations and collaborative examinations of student work.

OMLI Project Evaluation Research Results

The figure below diagrams the Research Logic Model for the OMLI project.

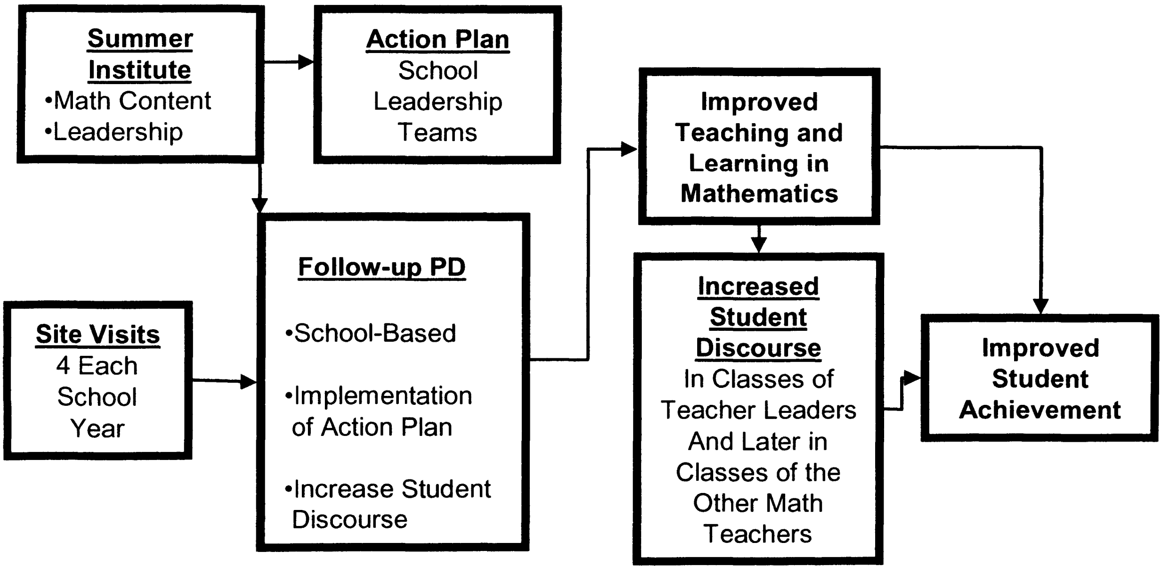


Figure 1. Oregon Mathematics Leadership Institute Partnership Research Logic Model.

The inputs to this Model are the activities and support provided by the project—namely, the series of intensive Summer Institutes followed up by the academic year site visits by project staff. The action plans developed by School Leadership Teams during the Institute were intended to shape the professional development activities in each school. The anticipated outcomes of the Model are the improved teaching and learning in mathematics in the participating schools with a direct emphasis on improving the quantity and quality of student mathematical discourse in classrooms. Ultimately, these intermediary outcomes were expected to result in improved student achievement.

Observation protocols were developed to provide measures of the quantity and quality of mathematical discourse. A report of this research, including the actual discourse observation protocol instruments can be found on the NSF-MSP website [10]. In this report, we wish to address the other two main evaluation research questions implied by the Research Logic Model:

1) Has the OMLI professional development prepared the Teacher Leaders for their leadership role in terms of mathematics content knowledge for teaching?
2) Has the OMLI project increased student achievement (as indicated by the percentage of students who demonstrate proficiency on the Oregon State Mathematics Assessments for Grades 3, 5, 8, and 10) in all participating K–12 schools?

Mathematical Content Knowledge for Teaching

At the conclusion of each Summer Institute, OMLI staff administered a post-survey of mathematics content knowledge to all SLT teachers. The pre-survey had been administered at the beginning of the 2005 Summer Institute or at the beginning of the first Summer Institute attended (in the case of new SLT teachers). The surveys comprised a series of mathematics problems developed and tested at The Study of Instructional Improvement and the "Learning Mathematics for Teaching Project" at the University of Michigan [11].

There were four versions of the surveys: two versions (A and B) for secondary teachers (middle school and high school teachers in grades 6-12) and two versions (A and B) for elementary teachers (grades K-5). Each group of teachers was randomly divided into two groups. One group completed version A for their respective grade level as the pre-survey and version B as the post-survey. The other group completed the surveys in the opposite order. Each survey included two to three standardized subscales. Raw scores on each subscale for each survey were converted to scale scores (z-scores) using lookup tables provided by University of Michigan staff. Tables 1 and 2 provide the mean scale score growth from pre-survey to post-survey for the overall group.

Both elementary and secondary SLT teachers demonstrated statistically significant gains from the pre-survey to the post-survey administered at the conclusion of the 2007 Summer Institute on the overall score and on all subscales.

Table 1

2007 Secondary SLT Teacher Content Knowledge Results

Scale	**Survey**	**N**	**M**	**SD**	**M Diff**	**SE**	***p***
Arithmetic and Algebra	Pre-	78	.767	.938	.397	.085	**<.001**
	Post-	78	1.164	.774			
Geometry	Pre-	78	.889	.554	.192	.063	**.003**
	Post-	78	1.081	.581			
Overall	Pre-	78	.761	.129	.055	.010	**<.001**
	Post-	78	.816	.107			

Table 2

Elementary SLT Teacher Content Knowledge Results

Scale	**Survey**	**N**	**M**	**SD**	**M Diff**	**SE**	***p***
Number Concepts and Operations	Pre-	84	-.100	.891	.343	.085	**<.001**
	Post-	84	.243	.799			
Geometry	Pre-	84	.228	.780	.479	.068	**<.001**
	Post-	84	.707	.802			
Patterns, Functions, and Algebra	Pre-	84	.101	.801	.372	.083	**<.001**
	Post-	84	.473	.807			
Overall	Pre-	84	.644	.155	.077	.010	**<.001**
	Post-	84	.720	.141			

Note. Statistically significant *p*-values ($p <= 0.05$) appear in boldface type. Raw scores on each subscale for each survey were converted to scale scores (*z*-scores) using lookup tables provided by University of Michigan.

This growth in content knowledge can be attributed to the content courses offered at the Summer Institutes. Each Summer Institute participant took two of the six mathematics content courses each summer. The next summer, they rotated and took two more content courses. It wasn't until the 2007 Summer Institute that participants had completed all six courses.

After completing two content courses at the conclusion of the 2005 Summer Institute, teachers demonstrated some growth in their mathematics content knowledge, but the growth was limited to subscales of the assessment that correlated closely to the content of the courses completed by the participants (see Table 3). After completing four of the six courses at the conclusion of the 2006 Summer Institute, teachers demonstrated significant growth in some areas. The secondary teachers demonstrated significant positive growth on the arithmetic and algebra scale, but growth on the geometry scale was not statistically significant. The elementary teachers demonstrated significant growth on the number concepts and operations scale and the geometry scale, but not on the patterns, functions, and algebra scale (see Table 4).

Table 3
2005 Teacher Content Knowledge Results

		2005 Summer Institute Course		
Grade Level		**Algebra & Functions**	**Data Analysis & Probability**	**Geometry**
Standardized Scale	**Overall Growth**	**Measurement & Change**	**Discrete Mathematics**	**Number Syst. & Operations**
Middle School and High School SLT Teachers				
Arithmetic and Algebra Scale	0.110	**0.382**	-0.033	0.012
Geometry Scale	0.191	**0.260**	0.112	0.185
N	82	25	29	32
Elementary School SLT Teachers				
Number Concepts and Operations Scale	0.138	**0.282**	-0.020	0.142
Geometry Scale	0.258	**0.338**	0.075	**0.340**
Patterns, Functions, and Algebra Scale	0.235	0.165	**0.312**	0.234
N	90	30	28	33

Note. The data shown in the body of this table represents the change in the mean scale scores for each group of participants from the pre-survey to the post-survey.

Table 4
2006 Teacher Content Knowledge Results

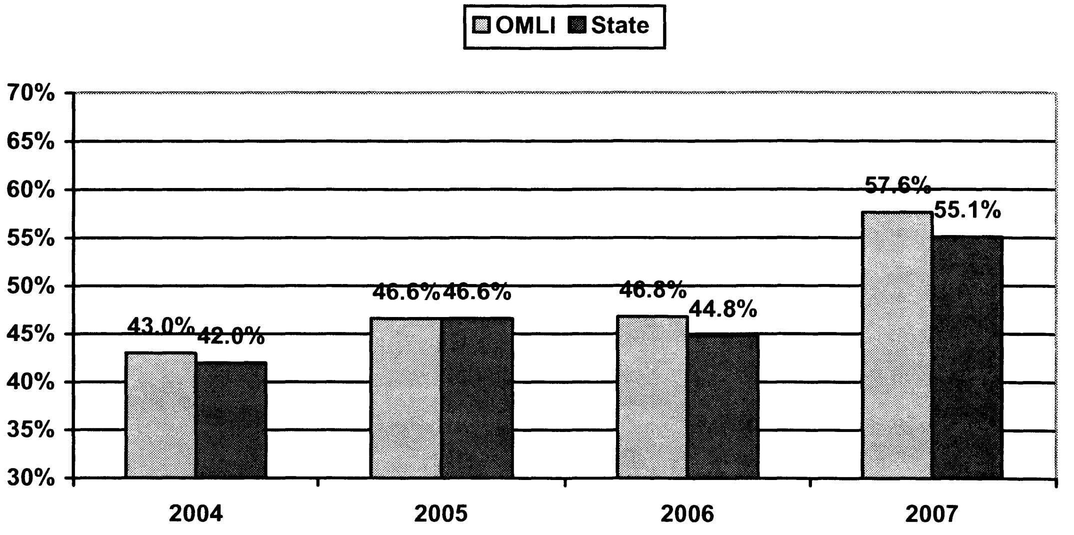
Participant Group/Scale	Survey	N	M	SD	*p*	M Diff	SE
Secondary SLT Teachers							
Arithmetic and Algebra	Pre-	81	.757	.905	**.003**	.168	.056
	Post-	81	.924	.855			
Geometry	Pre-	81	.862	.570	.087	.091	.053
	Post-	81	.953	.606			
Overall	Pre-	81	.758	.127	**.001**	.025	.007
	Post-	81	.783	.122			
Elementary SLT Teachers							
Number Concepts and Operations	Pre-	92	-.010	.883	**.003**	.214	.071
	Post-	92	.119	.802			
Geometry	Pre-	93	.248	.784	**.001**	.200	.056
	Post-	93	.448	.742			
Patterns, Functions, and Algebra	Pre-	93	.150	.745	.069	.140	.076
	Post-	93	.290	.815			
Overall	Pre-	93	.647	.150	**< .001**	.037	.008
	Post-	93	.684	.144			

Note. Statistically significant *p*-values ($p <= 0.05$) appear in boldface type. Raw scores on each subscale for each survey were converted to scale scores (*z*-scores) using lookup tables provided by University of Michigan.

After completing all six content courses at the conclusion of the 2007 Summer Institute, participants demonstrated significant content knowledge gains overall and on all subscales of the assessment (see Tables 1 and 2).

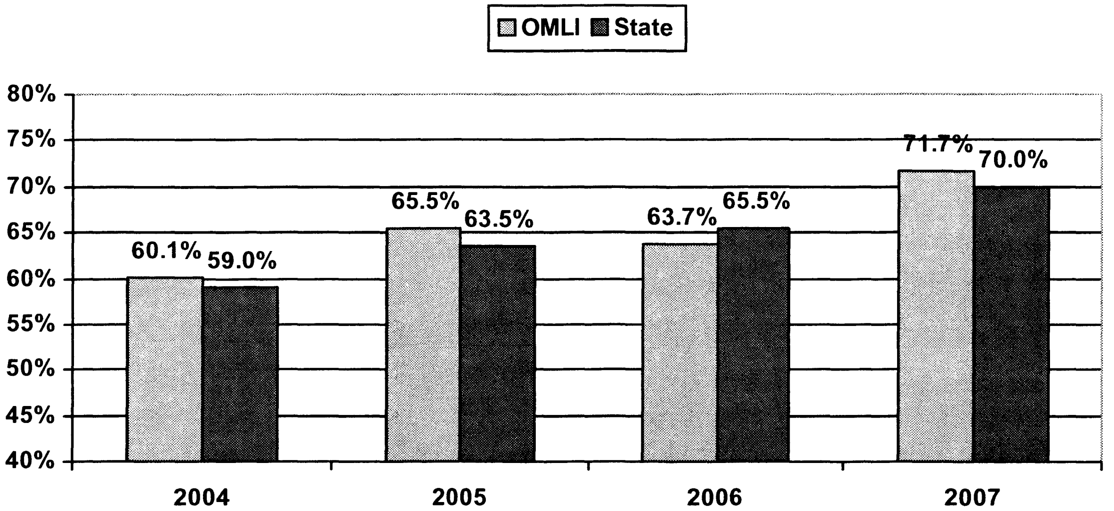
Analysis of Student Achievement

The school is the primary unit of change for the OMLI project. Thus, the evaluation examines trends in school-level student performance on the mathematics portion of the state assessment for the schools participating in the OMLI project compared to statewide averages. The following series of figures (Figures 2-5) show the percentage of students who met or exceeded the mathematics standard on the Oregon assessment of student performance for students in OMLI schools compared to the State average for each year from 2004 (2003–04 school year) through 2007 (2006–07 school year). All percentages represent the percentage of students who met or *exceeded the* mathematics standard weighted by the number of students assessed at each grade level. The 2006 assessment was administered after the first OMLI Summer Institute in 2005 and the 2007 assessment was administered after the second Summer Institute in 2006. Complications with the on-line administration during the implementation of the 2007 assessment makes it difficult to compare the 2007 results with those of previous years. However, comparison of the OMLI schools to the State averages is valid for all years including 2007 because the complications were experienced by all schools in the State.



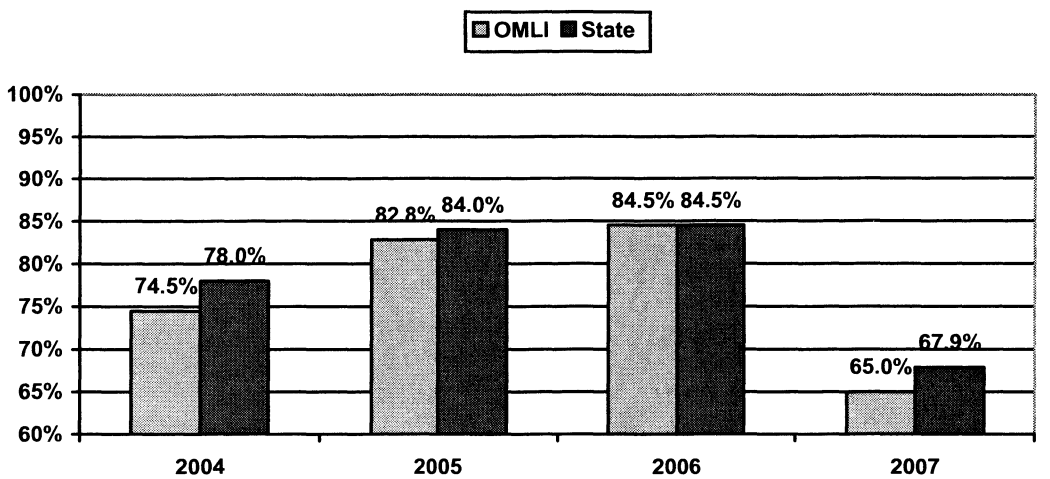
N = 12

Figure 2. Percentage of grade 10 students who met or exceeded the mathematics standard, 2004 through 2007.



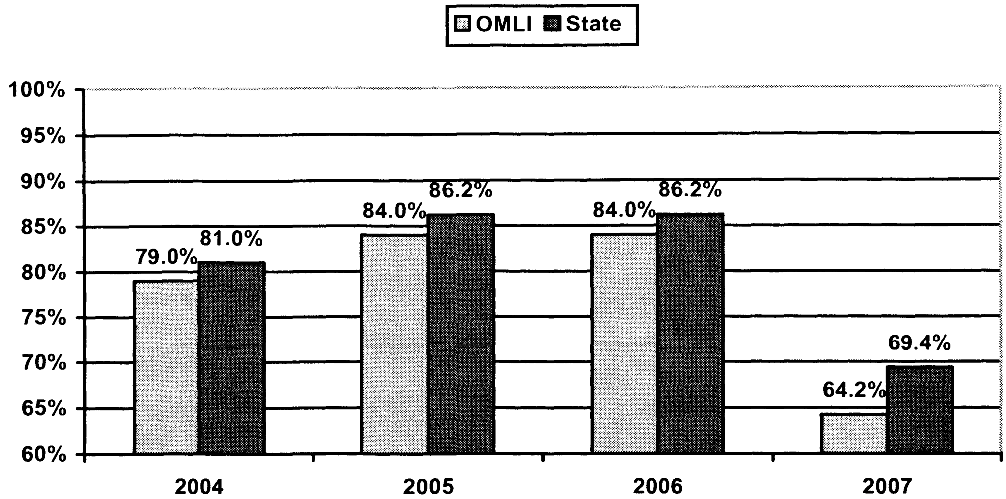
N=24

Figure 3. Percentage of grade 8 students who met or exceeded the mathematics standard, 2004 through 2007.



N = 46

Figure 4. Percentage of grade 5 students who met or exceeded the mathematics standard, 2004 through 2007.



N = 45

Figure 5. Percentage of grade 3 students who met or exceeded the mathematics standard, 2004 through 2007.

As shown in the graphs, results are inconclusive. The percentage of grades 3 and 5 students in OMLI schools who met or exceeded the standards was lower than the State average while the percentage of grades 8 and 10 students in OMLI schools was above the State average. This led us to revisit the logic model for the project (Figure 1) and note that simply using attendance at the Summer Institutes by participating teachers and administrators did not adequately reflect full participation in the project. This led us to collect information about the degree to which each school actually implemented practices promoted in the OMLI professional development. With input from the site visit staff, RMC Research developed a scoring rubric of thirteen traits for use by the site visit staff to rate the level of implementation of each school as of the end of the 2006–07 school year. The scoring rubric was composed of the following traits:

1) Quality of the School Leadership Team's action plan;
2) Implementation of the action plan;
3) Leadership exhibited by first teacher on School Leadership Team;
4) Leadership exhibited by second teacher on School Leadership Team;
5) Leadership and engagement exhibited by the school administrator on team;
6) Support of the district leadership team;
7) School policies/practices supported work of the School Leadership Team;
8) Stability of the School Leadership Team (in terms of turnover due to personnel moves);
9) School priority for mathematics;

10) Professional development responsibilities taken on by School Leadership Team;
11) Scope of professional development activities;
12) Use of professional learning tasks and protocols used in collegial leadership work; and,
13) Evidence of impact of the professional development on other teachers in the school.

The RMC Research Corporation analyzed the data from each school and identified two sets of five of the thirteen traits that were highly correlated to student achievement on the 2007 state assessment. One set was correlated to student achievement at the elementary level and the other set was correlated to student achievement at the secondary level. The following traits make up the Secondary Implementation Scale (SIS) and are correlated to student achievement in secondary schools (grades 8 and 10):

- Quality of the school action plan for improving mathematics teaching and learning developed by the School Leadership Team during the Summer Institutes;
- How well the School Leadership Team implemented the action plan;
- The degree to which the School Leadership Team conducted regular, school-based professional development with the other mathematics teachers in their school;
- The degree to which the school-based professional development reached all or a critical mass of mathematics teachers in the school; and,
- The degree to which the professional development utilized well-defined professional learning tasks and protocols developed by project staff and modeled during the Summer Institutes.

The following traits make up the Elementary Implementation Scale (EIS) and were correlated to student achievement in elementary schools (grades 3 and 5):

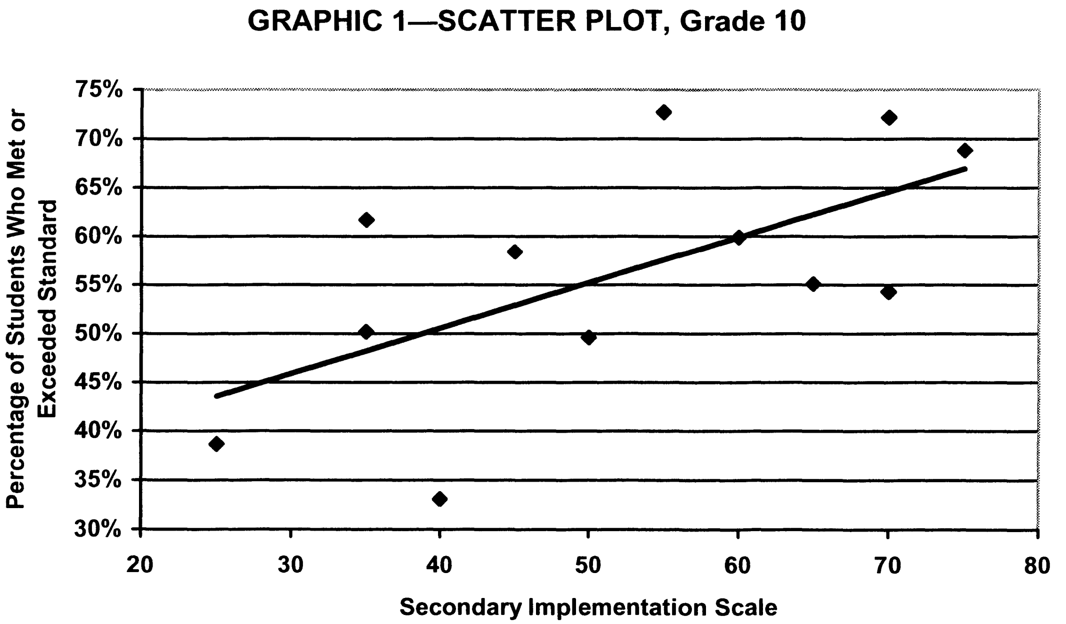
- Leadership qualities of the teachers on the School Leadership Team;
- Whether the School Leadership Team had a second teacher participating;
- The degree to which the school and district policies and practices are supportive of the work of the School Leadership Team;
- The degree to which mathematics is a priority for the school; and,
- The degree to which the professional development utilized well-defined professional learning tasks and protocols developed by project staff and modeled during the Summer Institutes.

In order to calculate the elementary and secondary implementation scale score for each OMLI school, RMC Research used the ratings for each school. The implementation scale score *was calculated* so that "0" represented the lowest possible score on the five traits and "100" represented the highest possible score. The analysis of the data focused on relationships between the implementation scale of the OMLI schools and the percentage of students in each school that met or exceeded the standard on the State mathematics assessments.

The RMC Research Corporation also took into account demographic factors such as the percentage of students who qualified for free or reduced price lunch (FRL) (proxy for socioeconomic level of the community), percentage of minority students, and the percentage of students with limited English proficiency (LEP). The percentage of students on FRL was the only demographic factor that had a significant relationship to student achievement. The FRL was used by RMC Research as a control variable in a regression analysis that used the OMLI implementation score as the independent variable and the percentage of students who met or exceeded the standard on the 2007 mathematics assessment as the dependent variable.

A series of graphics (Graphics 1-4) summarize the results of the analysis of student achievement at grades 10, 8, 5, and 3. Each graphic contains four components:

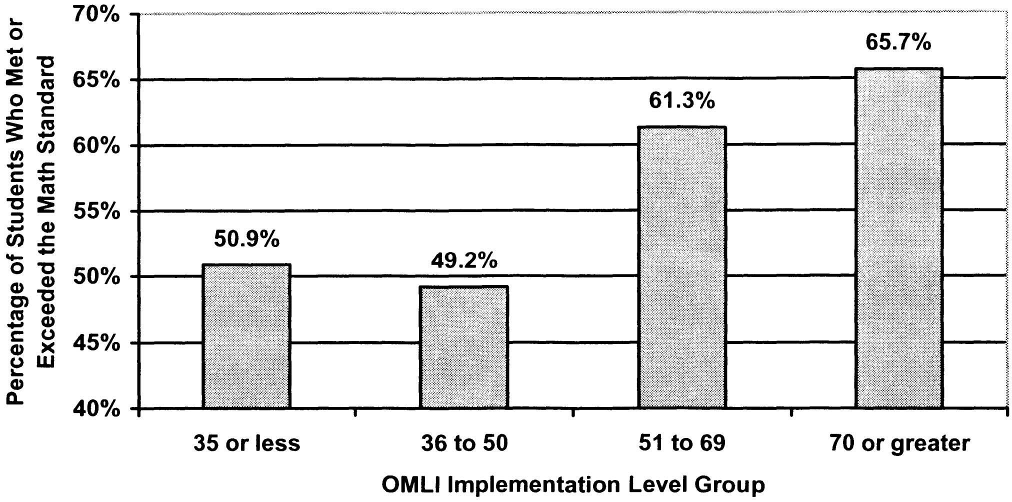
1) Scatter Plot—This graph shows the relationship between level of OMLI implementation as measured by either the elementary or secondary implementation scale and the percentage of students who met or exceeded the mathematics standard in 2007 for the respective grade level. Please note that this depicts school-level aggregates and is not weighted by the size of the school.
2) Implementation Level Group Bar Chart—Each school was assigned to an implementation level group based on their implementation scale. The RMC Research Corporation calculated the percentage of students who met or exceeded the mathematics standard for all the students in each group, weighted by the number of students who completed the assessment in each school. This bar graph shows the percentage of students who met or exceeded the mathematics standard for each implementation level group.
3) Implementation Level Group Data Table—This table contains the data used to plot the preceding bar graph.
4) Regression Analysis Results—This series of tables shows the results of the regression analysis of the data. Predictors considered in these models are the percentage of students who qualify for free or reduced price lunch and either the elementary or secondary implementation scale. The dependent variable is the percentage of students who met or exceeded the mathematics standard in 2007, weighted by the number of students in each school who completed the assessment. Noteworthy data is indicated with boldface type.



N = 12 Schools

Figure 6. Analysis of grade 10 student achievement.

GRAPHIC 1—IMPLEMENTATION LEVEL GROUP BAR CHART, Grade 10



GRAPHIC 1—IMPLEMENTATION LEVEL GROUP DATA TABLE, Grade 10

Elementary Implementation Index Score	*Number of Schools*	*Students Who Met/Exceeded Mathematics Standards*	*Students Assessed*	*Percentage of Students Who Met/Exceeded Standard*
35 or less	3	331	650	50.9%
36 to 50	3	722	1467	49.2%
51 to 69	3	691	1128	61.3%
70 or greater	3	1011	1539	65.7%

GRAPHIC 1—REGRESSION ANALYSIS RESULTS, Grade 10
ANOVA Results (b)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	41.453	2	20.726	6718.445	.000(a)
Residual	14.749	4781	.003		
Total	56.202	4783			

a Predictors: (Constant), Secondary Implementation Scale (SIS), Free or Reduced Price Lunch Percent (FRLP)

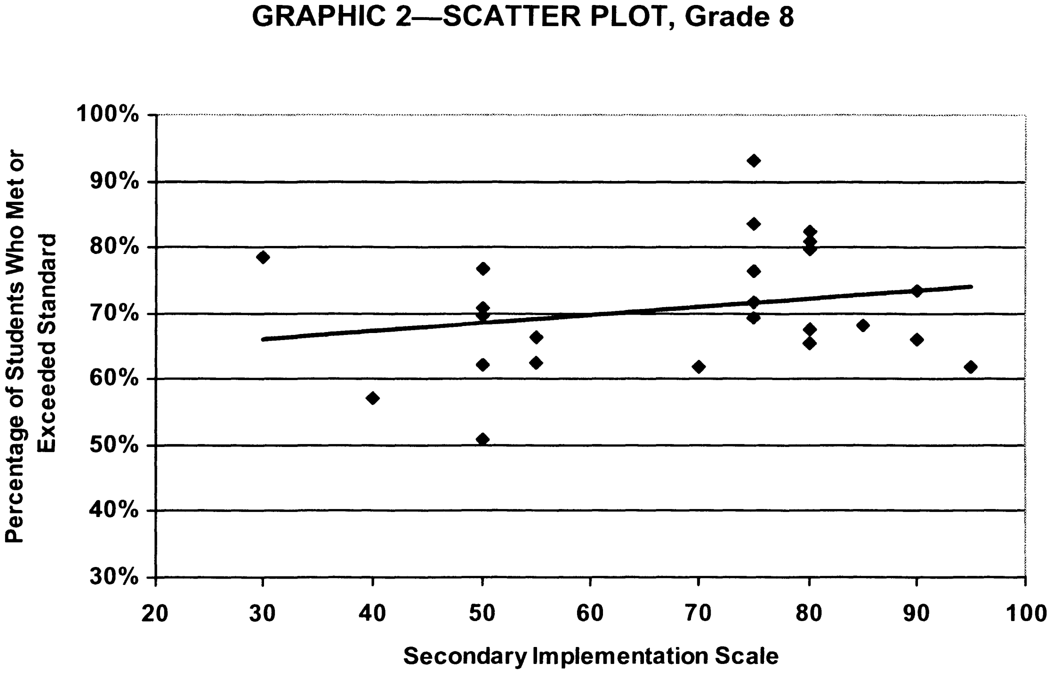
b Dependent Variable: Percentage of grade 10 students who met or exceeded mathematics standard in 2007.

R^2 = **.738** N = 12 Schools

Coefficients(a)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.593	.005		123.888	.000
FRLP	-.612	.008	-.664	-79.646	.000
SIS	.002	.000	**.320**	38.455	**.000**

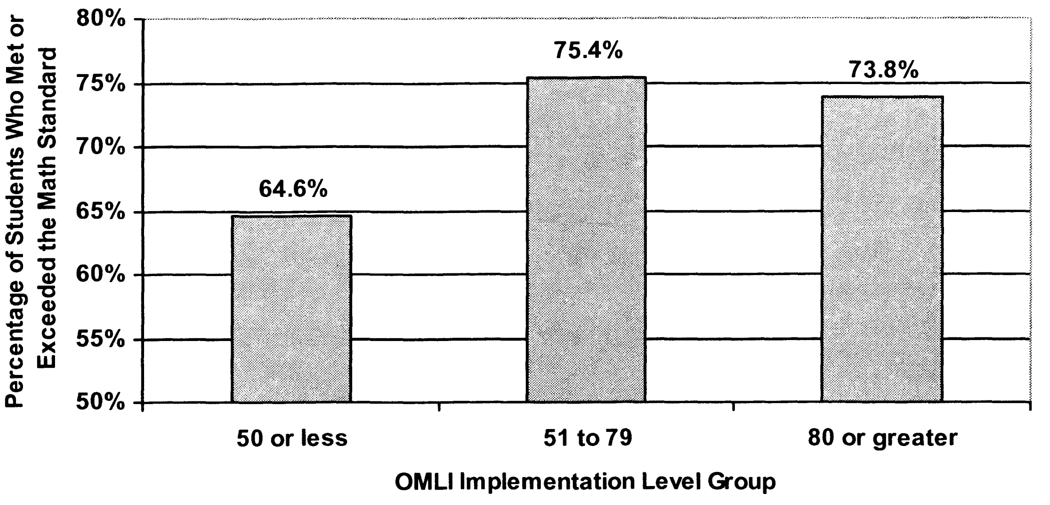
a Dependent Variable: Percentage of grade 10 students who met or exceeded mathematics standard in 2007.



N = 24 Schools

Figure 7. Analysis of grade 8 student achievement.

GRAPHIC 2—IMPLEMENTATION LEVEL GROUP BAR CHART, Grade 8



GRAPHIC 2—IMPLEMENTATION LEVEL GROUP DATA TABLE, Grade 8

Secondary Implementation Index Score	*Number of Schools*	*Students Who Met/Exceeded Mathematics Standards*	*Students Assessed*	*Percentage of Students Who Met/Exceeded Standard*
50 or less	7	1020	1578	64.6%
51 to 79	8	1513	2007	75.4%
80 or greater	9	1434	1944	73.8%

GRAPHIC 2—REGRESSION ANALYSIS RESULTS, Grade 8

ANOVA Results (b)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	30.901	2	15.450	3044.891	.000(a)
Residual	28.040	5526	.005		
Total	58.941	5528			

a Predictors: (Constant), Secondary Implementation Scale (SIS), Free or Reduced Price Lunch Percent (FRLP).

b Dependent Variable: Percentage of grade 8 students who met or exceeded mathematics standard in 2007.

R^2 = **.524** N = 24 Schools

Coefficients(a)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.777	.005		154.233	.000
FRLP	-.412	.006	-.652	-68401	.000
SIS	.001	.000	**.197**	20.651	**.000**

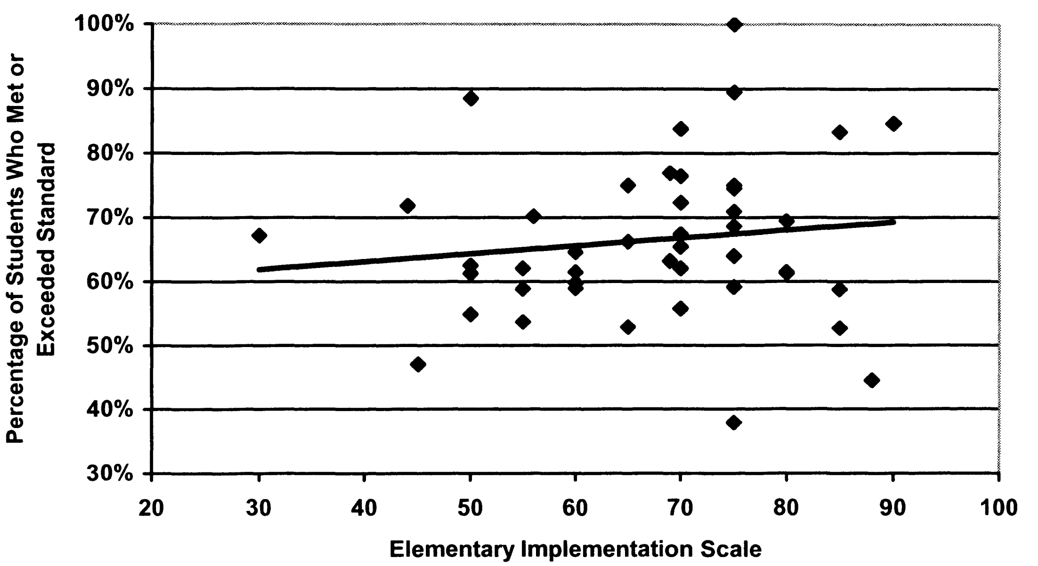
a Dependent Variable: Percentage of grade 8 students who met or exceeded mathematics standard in 2007.

The analysis of the data for grades 8 and 10 indicates that the degree to which schools implement the practices promoted by the OMLI project measured by the SIS was a significant positive predictor of student performance above and beyond what could be explained by the socioeconomic factor as indicated by the percentage of students who qualify for free and reduced lunch program (see Graphics 1 and 2). This relationship was particularly acute at grade 10 (R2=.738, Beta=.320) and grade 8 (R2=.524, Beta=.197). These predictors include the quality and implementation of the school action plan and regular, school-based, professional development that reaches the majority of the teaching staff. The use of well-defined professional learning tasks and protocols during school-based professional development are key elements.

Graphics 3 and 4 show the results of the analysis of the grades 3 and 5 data. The effect seen in grades 8 and 10 were evident to a lesser extent at grades 3 and 5 (Grade 3: R2=.224, Beta=.160; Grade 5: R2=.110, Beta=.068). Key factors accounted for by the EIS included the leadership qualities of the teachers on the School Leadership Team, whether the School

Leadership Team had more than one teacher participating, supportive school and district policies and practices, the degree to which mathematics is a priority for the school, and regular use of well-defined professional learning tasks and protocols during school-based professional development. Although there was a statistically significant relationship between these implementation factors and student achievement in mathematics, the model accounts for only a small portion of the variance in student achievement (note R^2 values). There are other factors at play beyond socioeconomics, demographics, and the traits measured using the OMLI implementation rubrics that influence student mathematics achievement at grades 3 and 5.

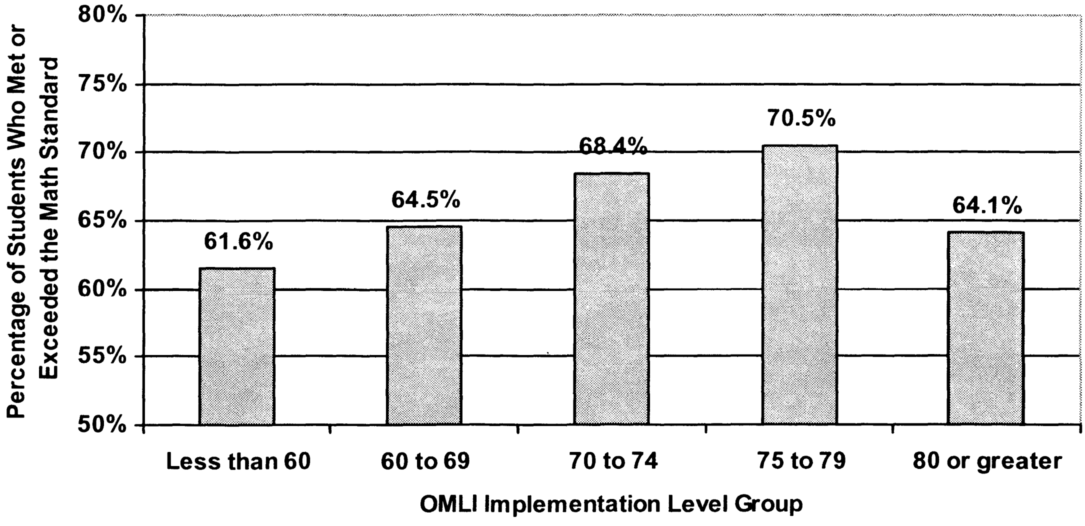
GRAPHIC 3—SCATTER PLOT, Grade 5



N = 45 Schools

Figure 8. Analysis of grade 5 student achievement.

GRAPHIC 3—IMPLEMENTATION LEVEL GROUP BAR CHART, Grade 5



GRAPHIC 3—IMPLEMENTATION LEVEL GROUP DATA TABLE, Grade 5

Elementary Implementation Index Score	*Number of Schools*	*Students Who Met/Exceeded Mathematics Standards*	*Students Assessed*	*Percentage of Students Who Met/Exceeded Standard*
Less than 60	11	435	706	61.6%
60 to 69	9	369	572	64.5%
70 to 74	7	359	525	68.4%
75 to 79	10	311	441	70.5%
80 or greater	8	412	643	64.1%

GRAPHIC 3—REGRESSION ANALYSIS RESULTS, Grade 5

ANOVA Results (b)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.009	2	2.005	177.334	.000(a)
Residual	32.599	2884	.011		
Total	36.608	2886			

a Predictors: (Constant), Elementary Implementation Scale (EIS), Free or Reduced Price Lunch Percent (FRLP).

b Dependent Variable: Percentage of grade 5 students who met or exceeded mathematics standard in 2007.

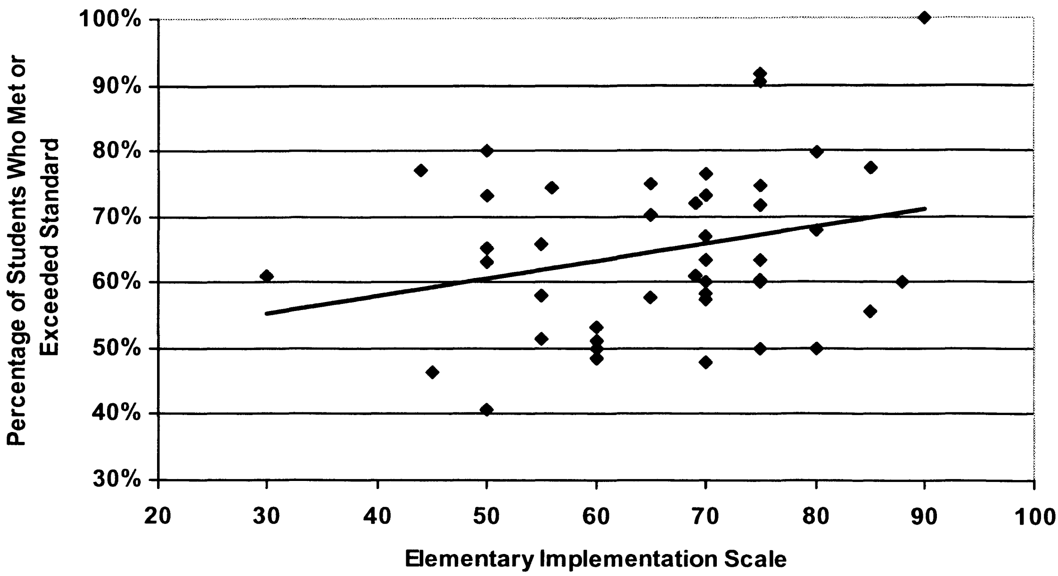
R^2 = **.110** N = 45 Schools

Coefficients(a)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.688	.013		54.486	.000
FRLP	-.172	.010	-.307	-16.917	.000
EIS	.001	.000	**.068**	3.747	**.000**

a Dependent Variable: Percentage of grade 5 students who met or exceeded mathematics standard in 2007.

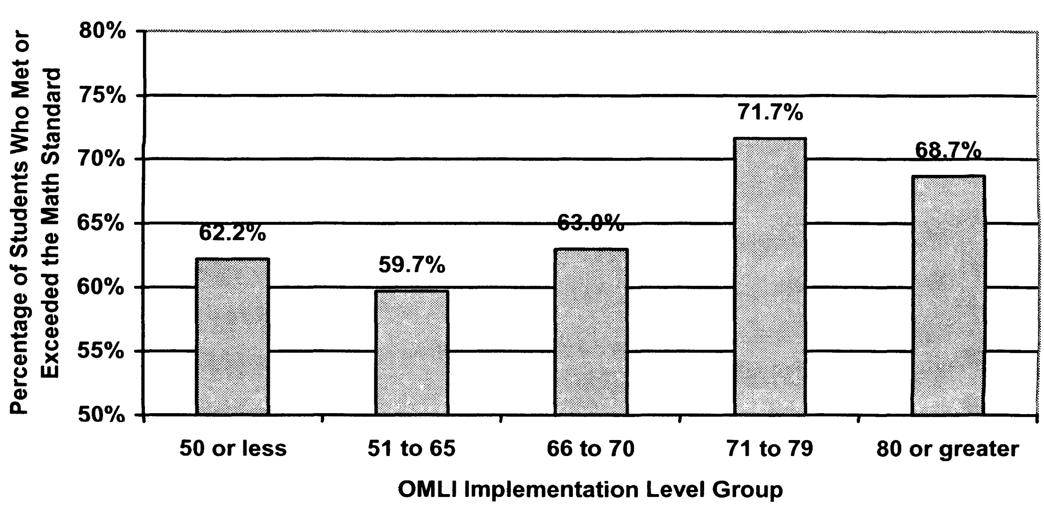
GRAPHIC 4—SCATTER PLOT, Grade 3



N = 44 Schools

Figure 9. Analysis of grade 3 student achievement.

GRAPHIC 4—IMPLEMENTATION LEVEL GROUP BAR CHART, Grade 3



GRAPHIC 4—IMPLEMENTATION LEVEL GROUP DATA TABLE, Grade 3

Elementary Implementation Index Score	*Number of Schools*	*Students Who Met/Exceeded Mathematics Standards*	*Students Assessed*	*Percentage of Students Who Met/Exceeded Standard*
50 or less	8	328	527	62.2%
51 to 65	11	490	821	59.7%
66 to 70	10	426	676	63.0%
71 to 79	8	289	403	71.7%
80 or greater	7	366	533	68.7%

GRAPHIC 4—REGRESSION ANALYSIS RESULTS, Grade 3

ANOVA Results (b)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	8.934	2	4.474	425.702	.000(a)
Residual	31.079	2957	.011		
Total	40.028	2959			

a Predictors: (Constant), Elementary Implementation Scale (EIS), Free or Reduced Price Lunch Percent(FRLP).

b Dependent Variable: Percentage of grade 3 students who met or exceeded mathematics standard in 2007.

R^2 = **.224** N = 44 Schools

Coefficients(a)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.647	.012		52.950	.000
FRLP	-.232	.010	-.403	-23.924	.000
EIS	.001	.000	**.160**	9.484	**.000**

a Dependent Variable: Percentage of grade 3 students who met or exceeded mathematics standard in 2007.

Concluding Remarks

We conclude by revisiting the two specific evaluation research questions considered in this paper, the first of which is: "Has the OMLI professional development prepared the Teacher Leaders for their leadership role in terms of mathematics content knowledge for teaching?" Using the Learning Mathematics for Teaching measures, we found that after completing two of the six courses at the first OMLI Summer Institute, very little growth was evident [10]. After most completed four of the six courses after the second OMLI Summer Institute, significant growth was evident on some subscales of the measures. After most participating teachers had completed all six courses after the third OMLI Summer Institute, significant growth was evident on all subscales and overall. Based on these measures, we conclude that the answer to this questions is "yes."

The other evaluation research question to be answered is: "Has the OMLI project increased student achievement (as indicated by the percentage of students who demonstrate proficiency on the Oregon State Mathematics Assessments for Grades 3, 5, 8, and 10) in all participating K–12 schools?" The degree to which schools implement the practices promoted by the OMLI project is a significant positive predictor of student performance above and beyond what can be explained by the socioeconomic factor as indicated by the percentage of students who qualify for free and reduced lunch program. This relationship is particularly acute at grades 10 and 8.

At grades 3 and 5, the degree to which schools implement the practices promoted by the OMLI project and socioeconomic factors are predictors of student performance. However, the regression model did not account for enough of the variance in student achievement. Evidently, there are other factors at play in elementary schools that are not accounted for by the traits measured by the implementation rubrics and socioeconomics, and a search for other possible factors is an ongoing effort in our evaluation plans.

Acknowledgments

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References

[1] *The Mathematical Education of Teachers*, Conference Board of the Mathematical Sciences, The American Mathematical Society, Providence, RI, 2001.

[2] S. Loucks-Horsley, N. Love, K.E. Stiles, S. Mundry, and P.W. Hewson, *Designing Professional Development for Teachers of Science and Mathematics*, Corwin Press, Inc., Thousand Oaks, CA, 2003.

[3] N. Seago, J. Mumme, and N. Branca, *Learning and Teaching Linear Functions: Video Cases for Mathematics Professional Development, 6-10,* Heinemann, Portsmouth, NH, 2004.

[4] C. Carroll and J. Mumme, *Learning to Lead Mathematics Professional Development,* Corwin Press, Inc., Thousand Oaks, CA, 2007.

[5] M. Driscoll, *Fostering Algebraic Thinking: A Guide for Teachers, Grades 6-10*, Heinemann, Portsmouth, NH, 2001.

[6] D. Schifter,V. Bastable, and S.J. Russell, *Developing Mathematical Ideas: Number and Operations,* Dale Seymour Publications, Parsippany, NJ, 1999.

[7] T.P. Carpenter, E. Fennema, M.L. Franke, L. Levi, and S.B. Empson, *Children's Mathematics: Cognitively Guided Instruction*, Heinemann, Portsmouth, NH, 1999.

[8] C.M. Grant, B.S. Nelson, E. Davidson, A. Sassi, A.S. Weinberg, and J. Bleiman, *Lenses on Learning: Modules 1, 2, and 3,* Education Development Center, Newton, MA, 2003.

[9] *Professional Standards for Teaching Mathematics,* National Council of Teachers of Mathematics, Reston, VA, 2000.

[10] D. Weaver and T. Dick, *Assessing the Quality and Quantity of Student Discourse in Mathematics Classrooms Year 1 Results*, Report on the National Science Foundation MSP-Net; Internet: (http://ormath.mspnet.org/index.cfm/14122).

[11] Learning Mathematics for Teaching Project website, Internet: (http://sitemaker.umich.edu/lmt/home).