2006 LASER Implementation Study Results

Prepared for:

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Background

The Washington State Legislature launched LASER statewide in 1999. Washington State LASER supports annual strategic planning institutes and curriculum showcases and supports a network of LASER alliances that provide the ongoing professional development, materials support, and technical assistance needed to implement inquiry-based science instruction in participating schools. Funding for the regional LASER alliances comes from a combination of state, private, and school district sources. Washington's Office of Superintendent of Public Instruction (OSPI), Battelle (a nonprofit developer of technology products for scientific and educational purposes), and the Pacific Science Center (a science education center for children located in Seattle) provide the leadership for Washington State LASER.

In 2004 RMC Research in cooperation with Washington State LASER and OSPI began to conduct a series of quasi-experimental research studies to explore the following hypothesis:

> *Intensive professional development on the implementation of coherent, inquiry-based K–5 science curriculum materials will have a positive impact on the student achievement in science.*

Early work in this area showed a significant but small relationship between the amount of inquiry-based science professional development and the percent of Grade 5 students who met the science standard on the 2004 science Washington Assessment of Student Learning (WASL), but the same results could not be replicated using the 2005 science WASL data. Both studies were limited to using existing school-level aggregate data sets.

A study conducted in West Valley School District in Yakima, Washington used a small set of student-level data to show a significant positive relationship between the number of science modules students experienced and their performance on both the 2004 and 2005 science WASL. RMC Research supported this study by conducting analysis that controlled for the demographic characteristics among students. At that point, the West Valley study was the most substantial and revealing study of the impact of the use of inquiry-based instructional materials on Grade 5 student achievement. The remainder of this report provides greater detail to support these statements.

In Winter of 2006 RMC Research, in cooperation with the Washington State LASER Alliance and project directors, conducted a follow-up to the research conducted in 2004 using student-level data provided by OSPI. This paper describes the results of this study.

Executive Summary

Since this study used data from schools involved in Washington State LASER to varying degrees, LASER is a major factor contributing to the results of this study. The remainder of this report provides greater detail to support these statements.

After controlling for student race/ethnicity and whether students qualify for special education, gifted, or free or reduced price lunch services, the following findings are evident.

- The number of modules (instructional units commonly referred to as kits) that students experienced is a significant positive predictor of Grade 5 student performance on the science WASL. The more modules students experience, the better they do on the science WASL.
- The degree to which teachers implement the modules with fidelity (according to the teacher guide) is a significant positive predictor of Grade 5 student performance on the science WASL. Students do better on the science WASL when their teachers use the materials the way they were intended to be used.
- Teachers that have no professional development in inquiry-based instruction are a significant negative predictor of Grade 5 student performance on the science WASL. Students in classes of teachers with no training on inquiry-based science are less likely to perform as well on the science WASL as students in classes of teachers who have received any training.
- The number of modules students used is a significant positive predictor of their performance on the properties of systems, changes in systems, and inquiry in science subscales on the Grade 5 science WASL.
- The number of modules, fidelity of implementation, and whether the teacher has received training are all significant predictors of student performance on the open-ended items on the Grade 5 science WASL, however, none of those variables were found to be predictors of student performance on the multiple choice items.
- The amount of professional development that the teacher participated in is a significant predictor of their student's performance on the Grade 5 science WASL for all measures except the structures of systems standard subscale. The more professional development the teacher has had on inquiry-based science the better his or her students will perform on the Grade 5 science WASL.

Two other more subtle findings support the argument that the use of inquiry-based science instruction is an effective means of closing the achievement gap in science. Schools involved in Washington State LASER are often schools that serve a higher proportion of minority and economically disadvantages students (see Exhibit 2). The implementation of the inquiry-based science is a way of raising the science achievement level of the students enabling them to catch up to the statewide average. (see Exhibit 3).

Furthermore, race and ethnicity was not a significant factor in the regression model of the classroom-level analysis relating teacher professional development of teachers to student achievement. This finding supports the argument that the use of inquiry-based science is effective with diverse populations.

Description of Data Sets

This study involved linking together multiple data sets with additional data gathered from schools through an online survey about the teaching and learning of science in individual classroom across Washington State. Below is a brief description of each data set and the survey.

WASL Data—In winter 2006, RMC Research entered into a data sharing agreement with OSPI to gain access to student-level Grade 5 WASL data for the science component. This data set included student-level results for the 2004 and 2005 Grade 5 science. The data set included student demographic data, overall science WASL results, results for 7 subscales, and school and teacher identifiers.

LASER Professional Development Database—This data set included teacher contact hours of participation in science professional development provided through Washington State LASER and through several National Science Foundation Local Systemic Change projects from July 1, 1999, through present. The database provided the total contact hours of professional development by type for each teacher who participated in LASER-related professional development. The database also contained information about the participants' school and grade level taught.

Level of LASER Implementation Data—Using school demographic data and the professional development data, RMC Research selected 96 schools in 36 school districts around the state of Washington to participate in the Implementation study. All schools were involved in the LASER project to some extent, however some were just beginning to implement inquiry-based science instruction while others had been involved for a much longer time. School districts were selected to provide a sample that represented the widest range of experience with inquiry-based science. RMC Research developed teacher and principal surveys in collaboration with the LASER project staff and LASER Alliance directors. The survey was converted into an online survey that was completed by participants over the internet (see paper versions of surveys in the Appendix A). In February 2006 RMC Research mailed to the principals of selected schools letters containing information about LASER and the study, and instructions for survey administration. The instructions including accounts and passwords for teachers and principals to use to access the online surveys. Online collection of survey responses and follow-up with selected schools continued through March 2006. By the beginning of April, 95 teachers and 37 principals in 44 schools completed surveys.

Implementation Factors that Impact Science WASL Results

In this analysis, RMC research explored the relationship between key factors relating to the implementation of inquiry-based science instruction gathered from the online surveys and the science WASL scores of the Grade 5 students. Using the school district, school name, and teacher name, RMC research matched the student-level 2005 science WASL data with the responses of teachers and principals on the online survey. The matching resulted in a data set that represented more that 1400 students in 54 classes in 36 schools.

RMC Research performed a multiple regression analysis to predict scores on the 2005 Grade 5 science scale score, raw score on multiple choice items, raw score on open-ended items, and the 5 science standards subscales, while controlling for student and teacher demographics. Student demographics included ethnicity (white vs. others and Hispanic vs. others) and whether the student qualified for free or reduced price lunch, gifted program services, and special education services. Teacher data factored into the model included number of years taught, years taught in current school, years taught science, whether

the teacher had a science degree, and the number of different modules (instructional units commonly referred to as kits) the teacher ever taught. Predictor variables included whether the teacher participated in professional development on inquiry-based science (none vs. any), the total number of science modules the students experienced during the 2004-2005 school year, and the fidelity of implementation of the modules.

After controlling for student demographics, 3 factors emerged as significant (at the $p <= 0.05$ level) predictors of Grade 5 student performance (overall scale score results) on the 2005 science WASL:

- **Number of Modules**—The total number of science modules the students experienced during the 2004–2005 school year;
- **No Teacher Training**—No teacher participated in professional development on inquiry-based science.; and
- **Fidelity**—The degree to which the teachers implements the instructional materials according to the teacher's guide (with fidelity).

The number of modules that students experience is the strongest predictor of student achievement on the 2005 science WASL (see Exhibit 1). In short, these results indicate that the more modules that students experience that are taught by teachers who followed the teachers guide, and are trained in inquiry-based science, the better they will do on the science WASL. It is important to note that teachers with no participation in professional development on inquiry-based science are a negative predictor of student achievement on the WASL.

Exhibit 1—Science Scale Score Regression Results

($R^2 = .34$)

Model Variable	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**T**	**Sig.**
(Constant)	383.504	3.573		107.334	<.001
Number of Modules	2.293	.892	.073	2.570	**.010**
No Teacher Training	-12.147	4.632	-.060	-2.622	**.009**
Fidelity	3.387	1.530	.051	2.213	**.027**

Note: Bold type indicates factors that are significant at the <.05 level

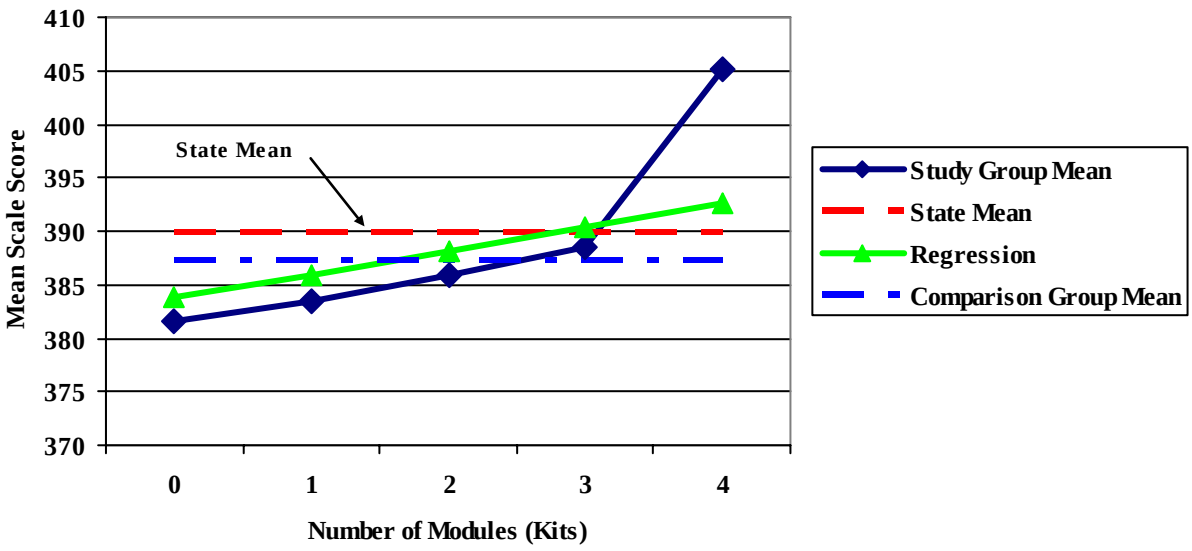
Unfortunately, the Grade 5 students in the classes of the teachers who completed the online survey (study group) was not at all representative of the students in Washington State who attempted the Grade 5 science WASL in 2005. As shown in Exhibit 2, the students in the classes in the study group contained a disproportionate number of students who qualified for free or reduced price lunch, Asian students, Hispanic students, migrant students, and students who were English language learners. As a result, comparing the mean WASL scores the students in the study group with that of students statewide was not possible. To address this issue, RMC Research identified a comparison group of school by matching the school characteristics, enrollment, and demographic composition of each school in the study group with the best possible match with schools that have no affiliation with the Washington State LASER (comparison group). As shown in Exhibit 2, the demographic composition of the 36 comparison schools more closely matches that of the study group schools.

Exhibit 3 is a graphical representation of the information contained in Exhibits 1 and 2. Exhibit 3 shows the relationship between the number of modules that students experience and their mean scale scores. The lower horizontal dashed line indicates the mean scores of the students in the comparison group and the higher dashed line indicates the statewide mean from Exhibit 2. The regression line represents the line of best fit of the study group means after controlling for the student demographic factors. Since the schools involved in Washington State LASER are often lower performing schools serving students a higher proportion of minority and economically disadvantages students, these findings also supports the argument that the use of inquiry-based science instruction is an effective means of closing the achievement gap in science.

Exhibit 2—Group Demographic Comparison

Category	Study Group	Comparison Group	Statewide
Number of Grade 5 Students	3159	2917	73626
Mean Grade 5 Science WASL Scale Score	387.0	387.2	389.8
Percent of Students Who Qualify for Free or Reduced Price Lunch	53.2%	47.1%	40.0%
Percent of Students who are English Language Learners	10.0%	10.9%	6.5%
Percent of Students Receiving Special Education Services	12.8%	10.9%	12.2%
Percent of Migrant Students	8.1%	5.0%	1.6%
Race/Ethnic Distribution			
American Indian/Alaskan Native	2.4%	2.8%	2.7%
Asian	3.0%	2.9%	8.0%
Black/African American	1.6%	1.9%	6.1%
Hispanic/Latino	30.9%	26.0%	13.6%
White	61.3%	65.2%	68.7%

Exhibit 3—
Relationship Between Number of Modules and Grade 5 Science WASL Results



Please note that the increase that is apparent from 3 modules to 4 modules is exaggerated compared to the regression line because of the smaller number of students in this group. As a result, the regression line would be a more accurate representation of this finding.

The analysis also included regression analysis of the science standard subscales and the item type using the same controls as that of the analysis of the scale score. As indicated in Exhibit 4, the number of modules students used is a significant predictor of their performance on the properties of systems, changes in systems, and inquiry in science subscales. Fidelity of implementation is a significant positive predictor for student performance on the inquiry in science subscale. No teacher training in inquiry-based science is a significant negative predictor of student performance on the structures of systems, changes in systems, and inquiry in science.

Exhibit 4—Science Standards Subscale and Item Type Regression Results

	% Of Variance Accounted for By The Model		Standardized Coefficients		
Standard	**Adjusted R^2**	**Model Variable**	**Beta**	**t**	**Sig.**
Properties of Systems	.14	**Number of Modules**	.088	2.726	**.006**
		No Teacher Training	-.036	-1.401	.161
		Fidelity	.025	.965	.335
Structure of Systems	.18	Number of Modules	.030	.968	.333
		No Teacher Training	-.053	-2.089	**.037**
		Fidelity	-.014	-.537	.591
Changes in Systems	.22	**Number of Modules**	.067	2.172	**.030**
		No Teacher Training	-.063	-2.548	**.011**
		Fidelity	.019	.741	.459
Inquiry in Science	.30	**Number of Modules**	.067	2.310	**.021**
		No Teacher Training	-.057	-2.423	**.016**
		Fidelity	.078	3.270	**.001**
Designing Solutions	.24	Number of Modules	.044	1.458	.145
		No Teacher Training	-.039	-1.580	.114
		Fidelity	.048	1.947	.052
Item Type					
Multiple Choice Items	.27	Number of Modules	.037	1.253	.211
		No Teacher Training	-.040	-1.681	.093
		Fidelity	.001	.024	.981
Open Ended Items	.32	**Number of Modules**	.084	2.896	**.004**
		No Teacher Training	-.068	-2.947	**.003**
		Fidelity	.078	3.323	**.001**

Note: Bold type indicates factors that are significant at the <.05 level

Exhibit 4 also shows that the number of modules, fidelity of implementation and whether the teacher has training are all significant predictors of student performance on the open-ended items on the Grade 5 science WASL, however, none of those variables were found to be significant predictors of student performance on the multiple choice items.

Impact of LASER Professional Development on Science WASL Results

In this analysis, RMC Research explored the relationship between the amount of professional development that teachers participated in and the science WASL scores of the Grade 5 students in their class. Using the LASER Professional Development database, RMC Research calculated the total number of hours of professional development on inquiry-based science each teacher participated in between July 1, 2002 and March 31, 2005 (the period just prior to the 2005 administration of the Grade 5 WASL). Using the school district, school name, and teacher name, RMC Research linked the professional development data to the 2005 Grade 5 science WASL data. This process resulted in a data set containing data for 15,781 students, in 721 classes, in 288 schools in 61 districts in Washington State.

Using this combined data set, RMC Research conducted a multiple regression analysis to predict scores on the 2005 Grade 5 science scale score, raw score on multiple choice items, raw score on open-ended items, and raw scores on the 5 Science Standards subscales, while controlling for student demographics. Student demographics included ethnicity (white vs. others and Hispanic vs. others) and whether the student qualified for free or reduced price lunch, gifted program services, and special education services. The predictor used was the total number of inquiry-based science professional development the teacher participated in between July 1, 2002 and March 31, 2005.

Exhibit 5—Student-Level Inquiry-Based Science Professional Development Regression Analysis Results

	% Of Variance Accounted for By The Model	Standardized Coefficients		
Variable	**Adjusted R^2**	**Beta**	**t**	**Sig.**
Scale Score	.29	.053	7.762	**<.001**
Multiple Choice Items	.26	.052	7.406	**<.001**
Open Ended Items	.25	.048	6.767	**<.001**
Properties of Systems	.12	.038	4.933	**<.001**
Structure of Systems	.16	.025	3.421	**.001**
Changes in Systems	.17	.050	6.680	**<.001**
Inquiry in Science	.24	.051	7.232	**<.001**
Designing Solutions	.22	.041	5.744	**<.001**

Note: Bold type indicates factors that are significant at the <.05 level

As shown in Exhibit 5, the amount of professional development that the teacher participated in is a significant predictor of their student's performance on the Grade 5 science WASL for all measures. The professional development had the greatest impact on the inquiry in science standard subscale, the overall scale score, and raw score on multiple choice and open-ended items. To summarize, the more professional development the teacher has had the better his or her students will perform on the Grade 5 science WASL. However, the overall effect of the professional development revealed in this analysis remains relatively small.

Further analysis of the same data aggregated to the classroom level shows yet a stronger relationship between the professional development and student achievement. RMC Research calculated the class aggregated for each of the major variables used in the previous analysis. However, at the class level, the

percent of students in any race or ethnic group was not a factor. Instead, the percent of students in the class who qualified for free or reduced price lunch, were English language learners, and who qualified for gifted and special education programs services proved to be the most significant controls for analysis. At the class level these factors accounted for between 49% and 63% of the variance in the student scale scores. Exhibit 6 shows, the amount of professional development that the teacher participated in is a significant predictor of their student's performance on the Grade 5 science WASL for all measures except structures of systems at the class level.

Exhibit 6—Class-Level Inquiry-Based Science Professional Development Regression Analysis Results

	% Of Variance Accounted for By The Model	Standardized Coefficients		
Variable	**Adjusted R^2**	**Beta**	**t**	**Sig.**
Scale Score	.63	.079	3.311	**.001**
Multiple Choice Items	.63	.080	3.415	**.001**
Open Ended Items	.58	.074	2.918	**.004**
Properties of Systems	.49	.089	3.232	**.001**
Structure of Systems	.56	.034	1.316	.189
Changes in Systems	.53	.100	3.734	**<.001**
Inquiry in Science	.55	.072	2.754	**.006**
Designing Solutions	.57	.075	2.966	**.003**

Conclusion

The findings in this study confirm the findings of an analysis of the relationship between teacher professional development and Grade 5 student achievement on the 2004 science WASL. It also, confirms a study of the relationship between the number of modules students experience and their achievement on the Grade 5 science WASL conducted last year in West Valley School District. Furthermore, this study provides insight into other important factors such as fidelity of implementation and the negative impact of teachers using the modules with no training.