LSC Principal Questionnaire Study: A Cross-Sectional Analysis of Data Collected Between 1997 and 2003

by

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INTRODUCTION

In addition to having a direct impact on teachers and their classroom practice via professional development and the adoption of high-quality instructional materials, the LSC program is intended to have a broader impact on the participating schools and districts. Data collected on the questionnaire administered to each participating school's principal provide an opportunity to examine the extent to which the LSC program has been a successful catalyst of school improvement. This study makes use of questionnaire data collected from principals in the LSC projects to-date to examine the impact of the LSC on seven outcomes:

1. The school's progress in moving towards excellence in mathematics/science education;
2. The mathematics/science achievement of students;
3. The proportion of teachers participating in LSC-professional development activities;
4. The proportion of teachers implementing the LSC-designated instructional materials;
5. Principals' attitudes toward reform-oriented teaching;
6. Principals' perceptions of their support for mathematics/science teaching; and
7. Principals' perceptions of the effect of resource availability on mathematics/science teaching.

The analyses of the first four outcomes can be conceptualized as examining the impacts of the LSC on schools, while the analyses of the last three can be thought of as impacts on the principal. Thus, this report is organized by the nature of the outcome variable (i.e., impacts on school vs. impacts on principals). Further, the analyses are conducted separately for mathematics and science projects as contextual factors (e.g., state-mandated high-stakes accountability measures in mathematics but not science) may have a differential effect on the two subjects. Because the data have a nested structure, with multiple questionnaires nested within schools, and schools within individual LSC projects, hierarchical modeling is used to examine these outcomes.

SAMPLE

Between 1997 and 2003, over 17,500 questionnaires were submitted by principals as part of the LSC Core Evaluation. Due to incomplete school information, some questionnaires were removed from these analyses, yielding a final data set that includes 17,380 questionnaires, representing 85 LSC projects. Table 1 shows the number of projects targeting each subject/grade-range.

Table 1
Projects Targeting Each Subject/Grade-Range

	Number of Projects
K–8 Science	42
K–8 Mathematics	29
6–12 Mathematics	19
6–12 Science	7
Total	**85**[†]

[†] The sum of projects is greater than the total as some projects target more than one subject/grade-range.

On the average, each mathematics project targeted about 800 teachers; on the average, each science project targeted about 1,100 teachers (see Table 2). However, project size varied widely, with the smallest project targeting only 49 teachers and the largest targeting over 4,000 teachers.

Table 2
Project Size

	Minimum	Maximum	Mean	Standard Deviation
Mathematics	49	4,079	792.91	827.90
Science	102	4,079	1,069.38	782.59

The principal questionnaires represent 4,510 schools targeted by the LSC projects. As can be seen in Table 3, the data set contains four or more questionnaires for about two-thirds of the schools. Less than 10 percent of the schools are represented by only one questionnaire.

Table 3
Number of Questionnaires Submitted by LSC Targeted Schools

	Number of Schools	Percent of Schools
1	356	8
2	535	12
3	827	18
4	1,066	24
5	1,214	27
6	445	10
7	67	1
Total	**4,510**	**100**

The main independent variable of interest in these analyses is the "age" of a project. This variable, designated as "project year," measures the number of years each LSC project has operated, with "0" indicating the project was in its Baseline Year. As can be seen in Table 4, the data are fairly well distributed in terms of project age.

Table 4
Project Year, by Targeted Subject

	Percent of Questionnaires	
	Mathematics (N = 8,106)	**Science (N = 10,609)**
0 (Baseline)	14	9
1	21	17
2	21	20
3	20	20
4	16	18
5	6	14
6	2	2

Examining the schools represented in the data set, about half are located in urban area and one-fourth in suburban communities, with the remaining roughly split between rural areas and towns/small cities (see Table 5). About one-fifth of the schools have no students classified as limited-English proficient, 5 percent of the schools have a majority of limited-English proficient students.

Table 5
Descriptive Statistics for Categorical School Variables

	Percent of Schools	
	Mathematics (N = 2,168)	**Science (N = 2,647)**
Community type		
Rural	9	14
Town or small city	9	14
Suburban	25	27
Urban	57	45
Percent of students classified as limited-English proficient		
0 percent	17	20
1–10 percent	50	50
11–50 percent	27	25
51 or more percent	6	5

As can be seen in Table 6, school sizes vary widely, ranging from a mere 5 to over 3,000 students. On average, 51 percent of the students in schools targeted for mathematics are classified as non-Asian minority, compared to 40 percent of students in schools targeted for science. In both subjects, nearly half of the students are eligible for free/reduced-price lunch.

Table 6
Descriptive Statistics for Continuous School Variables

	Minimum	Maximum	Mean	Standard Deviation
Mathematics				
Number of students in school	20.00	3,043.00	705.01	418.27
Percent of student body classified as Non-Asian minority	0.00	100.00	50.61	34.73
Percent of students in school eligible for free-reduced price lunch	0.00	100.00	49.13	30.07
Science				
Number of students in school	5.00	2,129.00	524.10	278.51
Percent of student body classified as Non-Asian minority	0.00	100.00	39.61	32.59
Percent of students in school eligible for free-reduced price lunch	0.00	100.00	46.04	28.76

Principal turnover may reduce the measurable impact of the LSC program on schools and principals. As can be seen in Table 7, data collected from projects in Year Two show that 79 percent of the principals had been in the school since the beginning of the project; 86 percent had been in the district since the beginning of the project. Data collected from Final Year projects show that only 45 percent of principals had been at the school since the beginning of the project; 61 percent had been in the district since the beginning of the project. Because of the high principal turnover rate in LSC schools, these analyses should be conceptualized as examining the impact of the LSC on schools and its leader, rather than on a specific set of people.

Table 7
Principal Retention Rates, by Data Collection Year

	Percent of Schools	
	Year Two	Final Year
Overall		
School	79	45
District	86	61
Science		
School	79	42
District	87	60
Mathematics		
School	78	46
District	85	61

Table 8 provides principal retention rates for each questionnaire included in these analyses. Roughly three-fourths of the principals had been in the same school since the beginning of the LSC; approximately 80 percent of principals had been in the same district. The retention numbers are higher than those presented earlier because they include data from all data collection years, including Baseline Year data when all principals would be considered "retained."

Table 8
Descriptive Statistics for Principal Questionnaires, by Targeted Subject

	Percent of Questionnaires	
	Mathematics (N = 8,106)	**Science (N = 10,609)**
Principal at school since beginning of the LSC		
No	28	31
Yes	73	69
Principal in district since beginning of the LSC		
No	20	22
Yes	80	78

It should be noted that, due to different patterns of missing data on the outcome variables, largely due to omission of a questionnaire item in various years, the number of cases utilized in each analysis varies. Descriptive statistics for each model are located in the Appendix.

ANALYSIS AND RESULTS

Impact of the LSC on Schools

The LSC principal questionnaire data have a nested structure with multiple questionnaires being nested within each school, and schools nested within projects. Statistical techniques that do not account for potential shared variance within groups in nested data structures can lead to incorrect estimates of the relationship between independent factors and the outcome. Hierarchical modeling is an appropriate technique for apportioning and predicting variance within and across groups in a nested data structure (Bryk & Raudenbush, 1992).[1]

The first four outcomes studied in these analyses, those examining the impact of the LSC on schools, are measured on categorical scales. These outcomes are the principal's perception of:

- The school's progress in moving towards excellence in mathematics/science education;
- The mathematics/science achievement of students;
- The proportion of teachers participating in LSC-professional development activities; and
- The proportion of teachers implementing the LSC-designated instructional materials;

Each categorical outcome was collapsed into a four-level ordinal variable. Table 9 shows the frequency distributions for these variables for both mathematics and science, though the results are similar across the two subjects. The majority of principals indicated that their schools were at least well along in moving towards excellence in mathematics/science. About three-quarters

[1] Bryk, A.S. & Raudenbush, W.W. (1992). *Hierarchical Linear Models: Applications and data analysis methods.* Newbury Park, CA: Sage Publications.

indicated that the achievement of students in their schools was improved compared to five years earlier. Roughly two-thirds of the principals indicated that the majority of the teachers in their schools were involved in LSC-professional development activities; a similar proportion of principals indicated that the majority of their teachers were implementing at least some of the LSC-designated instructional materials.

Table 9
Descriptive Statistics for Ordinal Outcome Variables

	Percent of Questionnaires	
	Mathematics	**Science**
Progress in moving towards excellence		
Not ideal	4	6
Beginning to improve	39	37
Well along in improving	42	40
Approaching ideal	15	17
Achievement of students compared to 5 years ago		
Much to somewhat worse	5	3
About the same	19	22
Somewhat improved	51	50
Much improved	25	25
Percent of teachers involved in LSC-professional development activities[†‡]		
0 Percent	8	7
10 Percent	9	8
20 Percent	6	6
30 Percent	5	5
40 Percent	3	4
50 Percent	5	6
60 Percent	4	4
70 Percent	6	7
80 Percent	10	10
90 Percent	15	13
100 Percent	29	30
Percent of teachers implementing the LSC-designated instructional materials[†‡]		
0 Percent	8	7
10 Percent	8	6
20 Percent	5	5
30 Percent	5	4
40 Percent	3	3
50 Percent	5	6
60 Percent	4	4
70 Percent	7	7
80 Percent	11	10
90 Percent	13	14
100 Percent	32	32

† The questionnaire asked principals to approximate to the nearest 10 percent.
‡ For analysis, these variables were collapsed to a four-point scale with the following categories: 0–20 percent, 30–50 percent, 60–80 percent, and 90 percent or more.

Due to limitations in modeling software, it was not feasible to include a third-level of nesting in the model to control for project membership. In an attempt to control for possible project effects, a set of dummy-coded project membership variables was included at the school level. Although this process does not allow for the testing of specific project effects (i.e., whether the effect of a certain variable on the outcome varies across projects), it should factor these effects out of the analyses. Thus, for each of the ordinal outcome variables, a two-level hierarchical linear model

(observations nested within schools) was used to investigate the relationship between the outcome variable and project year. In addition, because the impact of the LSC may be mediated by contextual effects, school demographic factors were controlled for in these models.

The independent variables included at the questionnaire level are:

- Project year;
- Principal at the same school since beginning of LSC project; and
- Principal in the same district since beginning of LSC project.

At the school level, the following independent variables are included:

- Number of students enrolled in the school;
- Percent of students in the school classified as non-Asian minority;
- Percent of students in the school eligible for free/reduced-price lunch;
- Percent of students in the school classified as limited-English proficient (dummy coded);
- Community type in which the school was located (dummy coded); and
- Project membership (dummy coded).

Since the statistical approaches employed assume that the variables are normally distributed, all continuous variables were examined for deviations from normality. Variables that were non-normally distributed were transformed as necessitated by the level and direction of skewness and kurtosis. These transformations are included in the Appendix.

For the analysis of ordinal outcomes, each questionnaire was treated as an "observation" with an underlying probability distribution that the outcome would be reported in each possible category. The analysis produces estimates of the likelihood that the outcome will be reported in each category based on the project year while controlling for a number of other factors. The statistical model for analyzing ordinal outcomes is a hierarchical generalized linear model. In the model, a "log odds" transformation of the probability for each rating category is estimated. The final estimates can then be converted to probabilities for ease of interpretation.

The outcome variable was organized as follows:

Y_{ij} = X = outcome variable, for observation i in project j, where

X = L = rating in lowest category
X = S = rating in second category
X = T = rating in third category
X = H = rating in highest category

Y_{Xij} = 1, if the outcome is in or below category X
Y_{Xij} = 0, if the outcome is above category X

$P(Y_{ij} = X) = \varphi_{Xi}$ = probability that the outcome is in category X

$P(Yx_{ij} = 1) = \varphi^*_{Xij}$ = probability that the outcome is in or below category X

$$\varphi_{NRij} = \varphi^*_{NRij}$$
$$\varphi_{Sij} + \varphi_{NRij} = \varphi^*_{Sij}$$
$$\varphi_{Oij} + \varphi_{Sij} + \varphi_{NRij} = \varphi^*_{Oij}$$
$$\varphi_{Aij} + \varphi_{Oij} + \varphi_{Sij} + \varphi_{NRij} = \varphi^*_{Aij} = 1$$

The expected value and variance for each category of the ordinal outcome variable are:

$$E(Y_{Xij}) = \varphi^*_{Xij}$$
$$Var(Y_{Xij}) = \frac{\varphi^*_{Xij}}{1-\varphi^*_{Xij}}$$

A logit link function was used to transform the ordinal outcome variable to estimate 3 values in model:

$$\eta_{NRij} = \ln\left(\frac{\varphi^*_{NRij}}{1-\varphi^*_{NRij}}\right)$$

$$\eta_{Sij} = \ln\left(\frac{\varphi^*_{Sij}}{1-\varphi^*_{Sij}}\right)$$

$$\eta_{Oij} = \ln\left(\frac{\varphi^*_{Oij}}{1-\varphi^*_{Oij}}\right)$$

Using this transformation, η_{Xij} is the logarithm of the predicted odds (or "log-odds") of a rating in or below category X. The predicted probability can be obtained by reversing the transformation using the formula:

$$P(Y_{Xij} = 1) = \frac{1}{1+e^{(-\eta_{Xij})}}$$

From these values, the predicted probabilities for an outcome in each category can be computed.

For each ordinal outcome the following model was run:

Level 1 Model

Prob[R = 1|B] = P'(1) = P(1)
Prob[R <= 2|B] = P'(2) = P(1) + P(2) + P(3)
Prob[R <= 3|B] = P'(3) = P(1) + P(2) + P(3)
Prob[R <= 4|B] = 1.0

where

P(1) = Prob[Y(1) = 1|B]
P(2) = Prob[Y(2) = 1|B]
P(3) = Prob[Y(3) = 1|B]

log[P'(1)/(1 - P'(1)] = B0
+ B1*(Project Year)
+ B2*(Principal in same school since beginning of Project)
+ B3*(Principal in same district since beginning of Project)
log[P'(2)/(1 - P'(2)] = B0
+ B1*(Project Year)
+ B2*(Principal in same school since beginning of Project)
+ B3*(Principal in same district since beginning of Project)
+ d(2)
log[P'(3)/(1 - P'(3)] = B0
+ B1*(Project Year)
+ B2*(Principal in same school since beginning of Project)
+ B3*(Principal in same district since beginning of Project)
+ d(3)

Level 2 Model

B0 = G00
+ G01*(Transformed Number of Students)
+ G02*(Transformed Percent of students classified as non-Asian minority)
+ G03*(Transformed Percent of students eligible for free/reduced-price lunch)
+ G04*(Limited English Proficient: 1-10 Percent)
+ G05*(Limited English Proficient: 11-50 Percent)
+ G06*(Limited English Proficient: 51 Percent of more)
+ G07*(Community Type: Rural)
+ G08*(Community Type: Town or Small City)
+ G09*(Community Type: Suburban)
+ $\sum G_i$*($Project_i$)
+ U0
B1 = G10
+ G11*(Transformed Number of Students)
+ G12*(Transformed Percent of students classified as non-Asian minority)
+ G13*(Transformed Percent of students eligible for free/reduced-price lunch)
+ G14*(Limited-English Proficient: 1-10 Percent)
+ G15*(Limited-English Proficient: 11-50 Percent)
+ G16*(Limited-English Proficient: 51 or more percent)
+ G17*(Community Type: Rural)
+ G18*(Community Type: Town or Small City)
+ G19*(Community Type: Suburban)
B2 = G20
B3 = G30

HLM 5.05[2] was used for all analyses, with variables entered using grand-mean centering, except for project year, which was entered uncentered. Categorical independent variables were entered as sets of dummy-coded variables. Results are presented separately for mathematics and science.

[2] Raudenbush, Stephen; Bryk, Anthony; Cheong, Yuk F.; Congdon, Richard; Scientific Software International, 2000.

Mathematics

The estimates of fixed effects for each outcome variable in mathematics are shown in Table 10. The individual project effects were included in the model to control for project-specific differences on each outcome, but are not shown because the analysis was focused on program-wide effects. It is important to note that the magnitude and direction of the regression coefficients should not be interpreted directly. Due to the transformation of the outcome variable and the centering of dummy-coded predictor variables, the coefficients must be converted to probabilities in order to draw meaningful interpretations and conclusions.

Table 10
Fixed Effects, by Ordinal Outcome: Mathematics

	Progress Towards Excellence	Student Achievement	Teacher Use of LSC Materials	Teacher Involvement in LSC PD
Intercept	-3.42***	-2.56***	-0.53***	-0.33***
	(0.08)	(0.11)	(0.08)	(0.08)
Threshold (2)	3.38***	2.01***	0.84***	0.80***
	(0.07)	(0.07)	(0.03)	(0.03)
Threshold (3)	5.92***	4.74***	1.96***	1.79***
	(0.08)	(0.08)	(0.04)	(0.04)
Questionnaire Characteristics				
Project Year	-0.17***	-0.28***	-0.39***	-0.39***
	(0.02)	(0.03)	(0.03)	(0.03)
Principal in School since Beginning of the LSC	-0.43***	-0.45***	-0.31**	-0.39***
	(0.11)	(0.12)	(0.10)	(0.10)
Principal in District since Beginning of the LSC	-0.28*	-0.24*	-0.09	-0.05
	(0.12)	(0.12)	(0.10)	(0.10)
School Characteristics				
Number of Students	-0.01	-0.02	-0.01	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)
Non-Asian Minority	0.66*	0.54	-0.47	-0.48
	(0.32)	(0.45)	(0.42)	(0.41)
Free or Reduced-Price Lunch	1.23***	0.57	1.29**	0.87*
	(0.30)	(0.41)	(0.38)	(0.37)
Limited-English Proficient (0 percent omitted)				
1–10 percent	0.05	0.03	-0.06	0.29
	(0.16)	(0.23)	(0.21)	(0.20)
11–50 percent	-0.05	-0.02	-0.18	0.25
	(0.18)	(0.26)	(0.24)	(0.24)
51 or more percent	-0.06	0.34	-0.80*	-0.33
	(0.30)	(0.43)	(0.40)	(0.40)
Community Type (Urban Omitted)				
Rural	0.35	0.27	0.59*	0.64*
	(0.24)	(0.29)	(0.27)	(0.26)
Suburban	0.31~	-0.01	0.09	0.25
	(0.16)	(0.24)	(0.22)	(0.21)
Town or Small City	0.29	0.29	0.75**	0.64**
	(0.21)	(0.27)	(0.25)	(0.24)

~ p < .10; * p < 0.05; ** p < 0.01; *** p < 0.001

The predicted probabilities of a school being in each category of the outcome variables, by project year, are shown in Figure 1. Project year is a significant predictor of each outcome, with

schools shifting from the lower categories to the top categories over time. In other words, there is a greater probability of schools being in the higher categories towards the end of the project than at the beginning. For example, in terms of the principal's perception of school progress towards excellence in mathematics education, at the Baseline Year (project year = 0), there was about a 50 percent probability that a school would be well along in improving or approaching ideal. By project year 5, the probability of a school being well along in improving or approaching ideal climbed to roughly 70 percent.

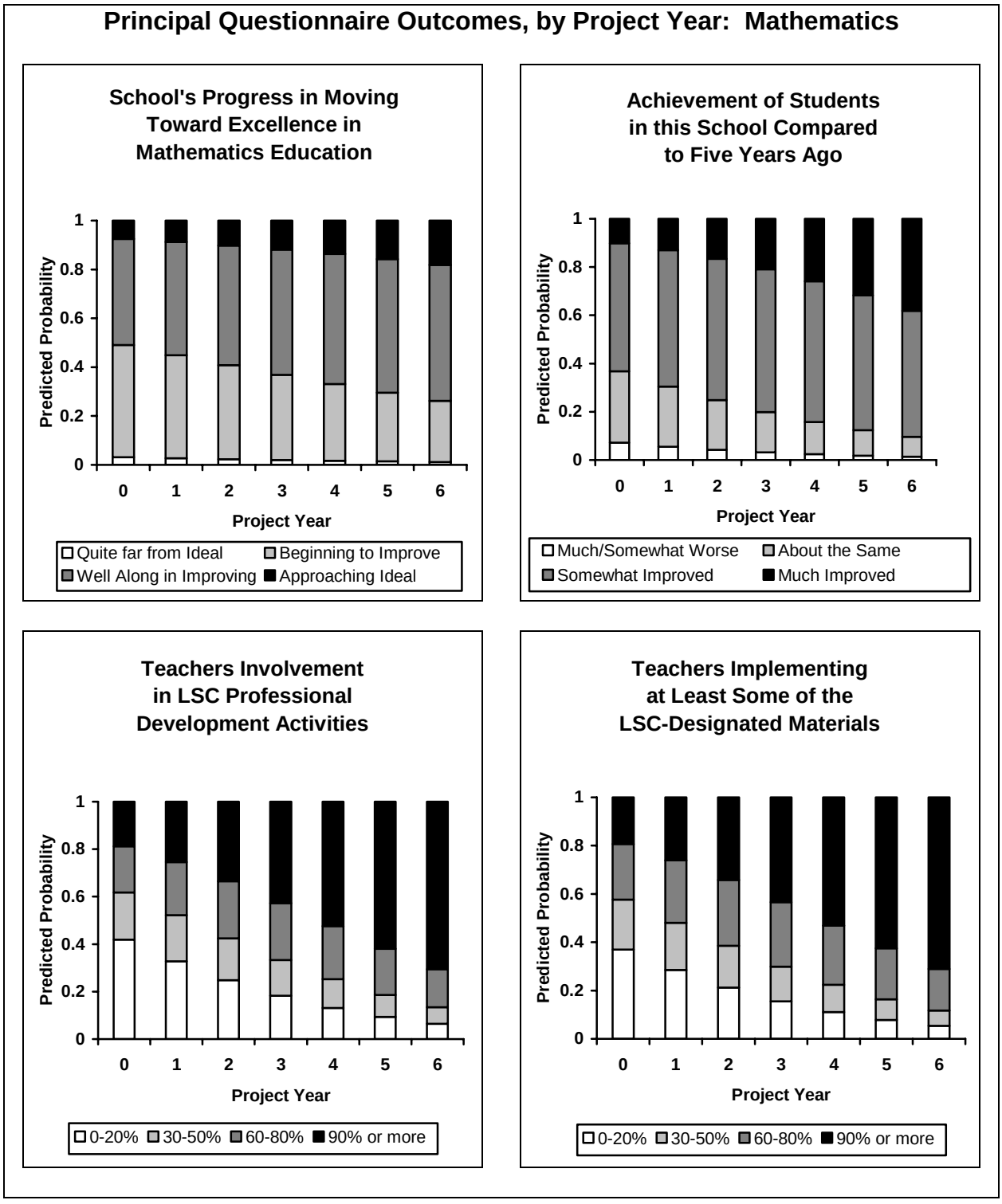

Principal Questionnaire Outcomes, by Project Year: Mathematics
School's Progress in Moving Toward Excellence in Mathematics Education
Predicted Probability
Project Year
Quite far from Ideal
Beginning to Improve
Well Along in Improving
Approaching Ideal
Achievement of Students in this School Compared to Five Years Ago
Much/Somewhat Worse
About the Same
Somewhat Improved
Much Improved
Teachers Involvement in LSC Professional Development Activities
0-20%
30-50%
60-80%
90% or more
Teachers Implementing at Least Some of the LSC-Designated Materials

Figure 1

Whether or not the principal had been in the school since the beginning of the LSC was also significantly related to each of the outcomes. For each outcome, the distribution of predicted probabilities is shifted towards the higher categories when the principal has been in the school since the beginning of the LSC (see Table 11).

Table 11
Predicted Probabilities, by Principal Retention in School: Mathematics

	Not Same Principal	Same Principal
Progress in moving towards excellence		
Not ideal	0.04	0.03
Beginning to improve	0.53	0.43
Well along in improving	0.37	0.45
Approaching ideal	0.06	0.08
Achievement of students compared to 5 years ago		
Much to somewhat worse	0.09	0.06
About the same	0.34	0.27
Somewhat improved	0.48	0.55
Much improved	0.08	0.12
Percent of teachers implementing the LSC-designated instructional materials		
0–20 Percent	0.42	0.34
30–50 Percent	0.21	0.21
60–80 Percent	0.21	0.24
90 or more Percent	0.16	0.21
Percent of teachers involved in LSC-professional development activities		
0–20 Percent	0.48	0.39
30–50 Percent	0.19	0.20
60–80 Percent	0.17	0.21
90 or more Percent	0.15	0.21

In addition, on 3 of the 4 outcomes (progress towards excellence, teachers implementing the LSC-designated instructional materials, and teachers involved in LSC professional development), schools with higher proportions of students eligible for free/reduced-price lunch are less likely to be in the higher categories than schools with smaller proportions of free/reduced-price eligible students.

Science

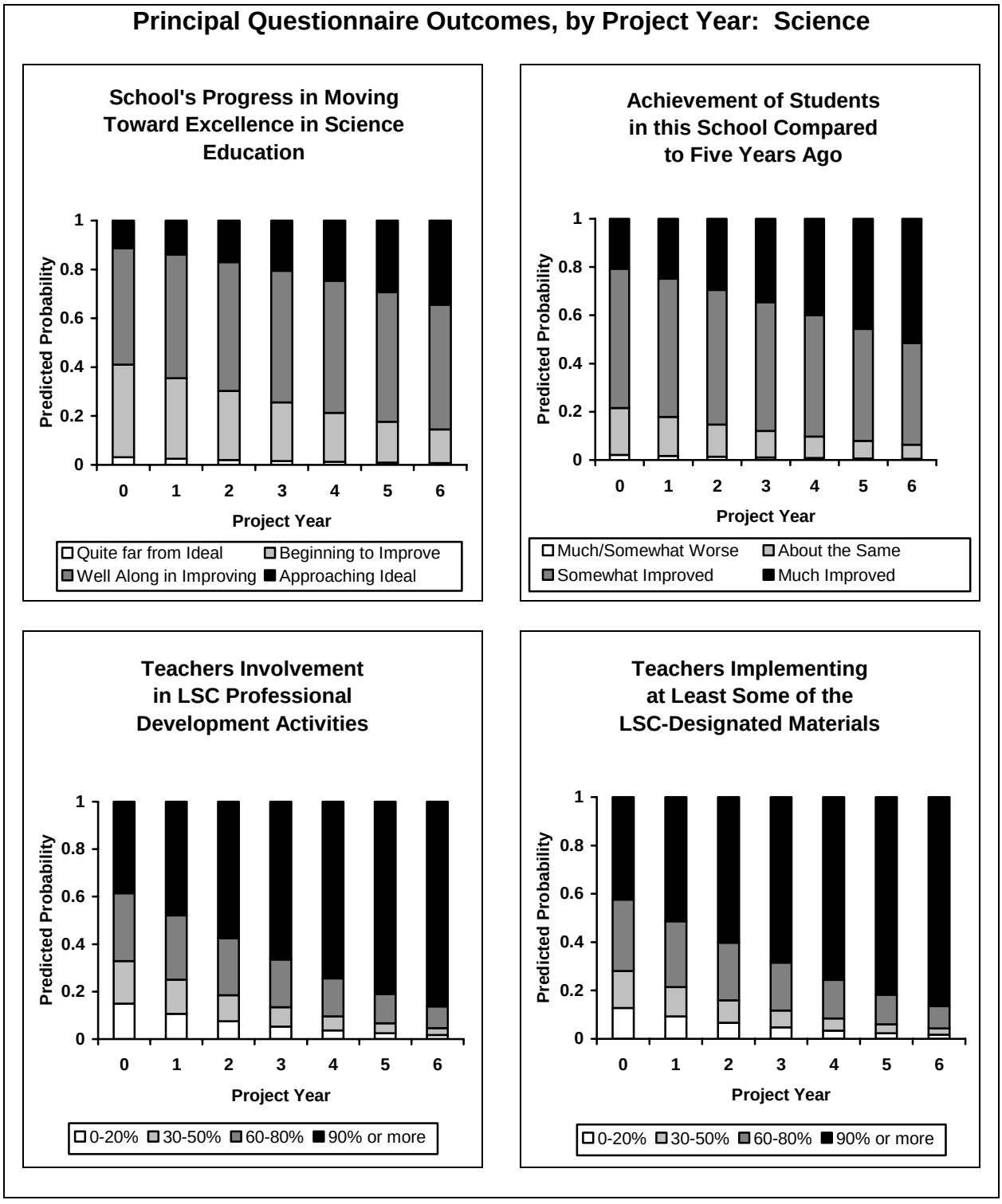
The estimates of fixed effects for each outcome variable in science are shown in Table 12. The individual project effects were included in the model to control for project-specific differences on each outcome, but are not shown because the analysis was focused on program-wide effects. Again, due to the transformations of the outcome variables, the magnitude and direction of the regression coefficients should not be interpreted directly.

Table 12
Fixed Effects, by Ordinal Outcome: Science

	Progress Towards Excellence	Student Achievement	Teacher Use of LSC Materials	Teacher Involvement in LSC PD
Intercept	-3.44***	-3.83***	-1.92***	-1.74***
	(0.06)	(0.08)	(0.04)	(0.04)
Threshold (2)	3.07***	2.54***	0.98***	1.02***
	(0.06)	(0.07)	(0.03)	(0.03)
Threshold (3)	5.49***	5.17***	2.23***	2.21***
	(0.07)	(0.08)	(0.04)	(0.04)
Questionnaire Characteristics				
Project Year	-0.24***	-0.23***	-0.36***	-0.38***
	(0.02)	(0.02)	(0.02)	(0.02)
Principal in School since Beginning of the LSC	-0.42***	-0.37***	-0.15~	-0.09
	(0.10)	(0.10)	(0.09)	(0.09)
Principal in District since Beginning of the LSC	-0.07	-0.14	-0.03	-0.10
	(0.10)	(0.10)	(0.09)	(0.09)
School Characteristics				
Number of Students	-0.02**	0.00	0.01*	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Non-Asian Minority	0.73**	0.51*	0.72**	0.62**
	(0.24)	(0.24)	(0.24)	(0.24)
Free or Reduced-Price Lunch	1.44***	0.45*	0.15	0.31
	(0.19)	(0.19)	(0.19)	(0.19)
Limited-English Proficient (0 percent omitted)				
1–10 percent	0.05	-0.17~	-0.17~	-0.20*
	(0.10)	(0.10)	(0.10)	(0.10)
11–50 percent	-0.01	-0.12	-0.18	-0.16
	(0.13)	(0.14)	(0.14)	(0.13)
51 or more percent	0.24	0.18	-0.34	-0.20
	(0.22)	(0.23)	(0.23)	(0.23)
Community Type (Urban Omitted)				
Rural	-0.03	-0.21	-0.43**	-0.45**
	(0.15)	(0.15)	(0.15)	(0.15)
Suburban	-0.02	-0.15	-0.20~	-0.18~
	(0.11)	(0.11)	(0.11)	(0.11)
Town or Small City	-0.17	-0.23	-0.30*	-0.31*
	(0.14)	(0.14)	(0.14)	(0.14)

~ p < .10; * p < 0.05; ** p < 0.01; *** p < 0.001

As was the case in mathematics, project year is a significant predictor of each outcome variable, with schools shifting from the lower categories to the higher categories over time. Figure 2 shows the predicted probabilities for each outcome by project year.


Principal Questionnaire Outcomes, by Project Year: Science
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Quite far from Ideal
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Much Improved
Teachers Involvement in LSC Professional Development Activities
0-20%
30-50%
60-80%
90% or more
Teachers Implementing at Least Some of the LSC-Designated Materials

Figure 2

Principal retention in school is significantly related to 3 of the 4 outcome variables: progress towards excellence, student achievement, and teacher use of the LSC-designated instructional materials. Table 13 shows the predicted probabilities for each of these outcomes by whether or not the principal was in the school since the beginning of the LSC. For all three outcomes, having the same principal since the beginning of the LSC increased the probability of a school being in a higher category.

Table 13
Predicted Probabilities, by Principal Retention in School: Science

	Not Same Principal	Same Principal
Progress in moving towards excellence		
Not ideal	0.04	0.03
Beginning to improve	0.44	0.35
Well along in improving	0.43	0.49
Approaching ideal	0.09	0.13
Achievement of students compared to five years ago		
Much to somewhat worse	0.03	0.02
About the same	0.23	0.17
Somewhat improved	0.57	0.58
Much improved	0.17	0.23
Percent of teachers implementing the LSC-designated instructional materials		
0–20 Percent	0.14	0.12
30–50 Percent	0.16	0.15
60–80 Percent	0.30	0.29
90 or more Percent	0.40	0.44

On all four outcomes, schools with higher proportions of non-Asian minority students are less likely to be in the higher categories than schools with smaller proportions of non-Asian minority students.

Impact of LSC on Principals

In terms of the impact of the LSC on principals, the three outcome variables of interest are composite scores[3] measuring:

- Principals' attitudes toward reform-oriented teaching ;
- Principals' perceptions of their support for mathematics/science teaching; and
- Principals' perceptions of the effect of resource availability on mathematics/science teaching.

These composite scores are measured on continuous scales. Because their distributions were not normally distributed, each was transformed as necessitated by the level and direction of

[3] See <http://www.horizon-research.com/LSC/news/composites/composites.pdf> for definitions of the principal composites.

skewness and kurtosis. Table 14 shows descriptive statistics for the original and transformed values of the three composite variables investigated in these analyses.

Table 14
Descriptive Statistics for Continuous Outcome Variables

	Minimum	Maximum	Mean	Standard Deviation
Mathematics				
Attitudes Toward Teaching				
Original	37.50	100.00	89.97	9.61
Transformed—arcsine (square root(original/100))	0.66	1.57	1.30	0.18
Principal Support				
Original	20.00	100.00	84.24	11.48
Transformed—$(original/100)^3$	0.01	1.00	0.63	0.22
Effect of Resource Availability				
Original	20.00	100.00	80.83	14.56
Transformed—arcsine(square root(original/100))	0.46	1.57	1.15	0.21
Science				
Attitudes Toward Teaching				
Original	50.00	100.00	89.69	8.87
Transformed—$LN((original/100)^{0.35}-(1-original/100)^{0.35}+5)$	-0.69	0.41	0.06	0.21
Principal Support				
Original	20.00	100.00	83.14	11.19
Transformed—$(original/100)^{2.75}$	0.01	1.00	0.63	0.21
Effect of Resource Availability				
Original	20.00	100.00	79.69	16.51
Transformed—arcsine(original/100)	0.20	1.57	0.99	0.31

In general, principals reported fairly positive views towards reform-oriented teaching practices. They also perceived themselves as having high levels of support for mathematics/science teaching. The effect of resource availability composite, a measure of the degree to which resource availability encourages or inhibits effective instruction, was also relatively high; in other words, the resources available for mathematics/science instruction encouraged effective instruction.

For each continuous outcome, a three-level hierarchical linear model (observations nested within schools nested within projects) was used to investigate the relationship between principals' composite scores and project year. In addition, school demographic factors were controlled for in these models, for example, the type of community in which a school was located.

The independent variables included at the observation level were:

- Project year;
- Principal at the same school since beginning of LSC project; and
- Principal in the same district since beginning of LSC project.

At the school level, the following independent variables were included:

- Number of students enrolled in the school;

- Percent of students in the school classified as non-Asian minority;
- Percent of students in the school eligible for free/reduced-price lunch;
- Percent of students in the school classified as limited-English proficient (dummy coded); and
- Community type in which the school was located (dummy coded)

At the project level, the only independent variable included was:

- Number of teachers targeted by the project.

For each continuous outcome the following model was run:

Level 1 Model

Y = P0
+ P1*(Project Year)
+ P2*(Principal in school since beginning of project)
+ P3*(Principal in district since beginning of project)
+ E

Level 2 Model

P0 = B00
+ B01*(Transformed Number of Students in school)
+ B02*(Transformed Percent of students classified as non-Asian minority)
+ B03*(Transformed Percent of students eligible for free/reduced-price lunch)
+ B04*(Limited-English Proficient: 1-10 Percent)
+ B05*(Limited-English Proficient: 11-50 Percent)
+ B06*(Limited-English Proficient: 51 or more Percent)
+ B07*(Community Type: Rural)
+ B08*(Community Type: Town)
+ B09*(Community Type: Suburban)
+ R0

P1 = B10
+ B11*(Transformed Number of Students in school)
+ B12*(Transformed Percent of students classified as non-Asian minority)
+ B13*(Transformed Percent of students eligible for free/reduced-price lunch)
+ B14*(Limited-English Proficient: 1-10 Percent)
+ B15*(Limited-English Proficient: 11-50 Percent)
+ B16*(Limited-English Proficient: 51 or more Percent)
+ B17*(Community Type: Rural)
+ B18*(Community Type: Town)
+ B19*(Community Type: Suburban)

P2 = B20
P3 = B30

Level 3 Model

B00 = G000 + G001*(Transformed Number of Targeted Teachers) + U00
B01 = G010
B02 = G020
B03 = G030
B04 = G040

B05 = G050
B06 = G060
B07 = G070
B08 = G080
B09 = G090
B10 = G100 + G101*(Transformed Number of Targeted Teachers) + U10
B11 = G110
B12 = G120
B13 = G130
B14 = G140
B15 = G150
B16 = G160
B17 = G170
B18 = G180
B19 = G190
B20 = G200
B30 = G300

HLM 5.05 was used for all analyses, with variables entered using grand-mean centering, except for project year which was entered uncentered. Categorical variables were entered as sets of dummy-coded variables. In addition, the random effects were tested for inclusion in each model (i.e., the relationship between the level one predictor variable and the outcome variable varied across projects).

For these models, the fixed effects estimates of main effects on the outcome variables are shown in Table 15. Project year is not a significant predictor of these outcome variables, with one exception. In science, scores on the principal perceptions of the effect of resource availability composite is positively related to project year. In other words, over time principals report that the resources available for science instruction are more likely to encourage effective instruction rather than inhibit it.

Table 15
Fixed Effects for Each Composite, by Targeted Subject

	Mathematics			Science		
	Attitudes Toward Teaching	**Principal Support**	**Effect of Resource Availability**	**Attitudes Toward Teaching**	**Principal Support**	**Effect of Resource Availability**
Intercept	1.30***	0.64***	1.15***	0.05***	0.63***	0.95***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Questionnaire Characteristics						
Project Year	-0.01~	0.00	0.01	0.00	0.00	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Principal in School since Beginning of the LSC	-0.01	0.01	0.00	0.00	0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Principal in District since Beginning of the LSC	0.02	-0.02	0.02	0.00	0.01	-0.01
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.03)
School Characteristics						
School Size	0.00*	0.00	0.00	0.00	0.00*	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Non-Asian Minority	0.04	-0.03	0.01	0.04	0.04	0.03
	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)
Free or Reduced-Price Lunch	0.00	0.00	-0.01	-0.02	-0.05	0.00
	(0.03)	(0.04)	(0.04)	(0.03)	(0.03)	(0.05)
Limited-English Proficient (0 percent omitted)						
1–10 percent	-0.02	0.00	-0.03	0.01	0.00	-0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
11–50 percent	-0.04*	-0.01	-0.05*	0.02	0.01	-0.06~
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
51 or more percent	0.02	0.04	0.03	0.02	0.05	-0.03
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Community Type (Urban Omitted)						
Rural	-0.05*	-0.06*	-0.08**	-0.02	0.03	-0.04
	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)
Suburban	0.01	-0.03	-0.03	0.02	0.01	-0.07*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Town or Small City	0.01	-0.08**	-0.05~	0.00	0.04	-0.06~
	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)
Project Characteristics						
Number of Targeted Teachers	0.00~	0.00	0.00	0.00	0.00~	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

~ p < .10; * p < 0.05; ** p < 0.01; *** p < 0.001

The lack of significant relationships between project year and the other outcomes variables may be due to a ceiling effect on composite scores; since the composite scores are all relatively high, there is little room for growth.

CONCLUSIONS

These analyses indicate that the LSC appears to be achieving a number of the intended school-level impacts. As the LSC projects mature, principals report a higher proportion of teachers participating in LSC professional development and using at least some of the LSC-designated instructional materials in their classroom instruction. This result is seen in both mathematics and science projects. These analyses also indicate that schools targeted by the LSC are, according to their principals, moving towards excellence in their mathematics/science instructional programs and that student achievement in the targeted subject has improved over time. Interestingly, principal stability tends to be a significant, positive predictor of these outcomes.

In regards to principals, the LSC does not appear to be having much of an impact on principals' attitudes towards reform-oriented teaching or perceptions of their support for mathematics/science teaching. The lack of a significant relationship may be due to the relatively high scores on these composites, leaving little room for growth. Principal turnover may also have a greater effect on the analysis of this set of outcomes as the questionnaire items comprising the composites ask about the principal's opinion, which likely changes from one individual to the next, rather than the status of the school which may be a more objective measure.

Principals in LSC projects targeting science do indicate that resource availability has become more positive over time, but this result was not seen in projects targeting mathematics. This finding may be attributable to the LSC increasing the emphasis on science instruction. By requiring the adoption of high-quality instructional materials, it is quite likely that the LSC is responsible for providing teachers with materials for teaching science when few, if any, such resources existed before the LSC.

It is important to note that all of the outcomes examined in these analyses are based upon self-report data. Thus, principal reports of impacts (e.g., proportion of teachers involved in LSC professional development) may or may not be supported by other, more objective, measures (such as project records of teacher participation).

APPENDIX

Table A-1
Descriptive Statistics for Continuous School Variables

	Minimum	Maximum	Mean	Standard Deviation
Mathematics				
Number of Students in School				
Original	20.00	3,043.00	705.00	418.27
Transformed—square root (original)	4.47	55.16	25.46	7.55
Percent of Student body classified as Non-Asian minority				
Original	0.00	100.00	50.61	34.73
Transformed—(arcsine(square root(original/100)))$^{1.5}$	0.00	1.35	0.8357	0.3321
Percent of students in school eligible for free-reduced price lunch				
Original	0.00	100.00	49.13	30.07
Transformed—arcsine(square root(original/100))	0.00	1.57	0.7759	0.3573
Science				
Number of Students in School				
Original	5.00	2,129.00	524.00	278.51
Transformed—square root(original)	2.12	46.14	22.04	6.20
Percent of Student body classified as Non-Asian minority				
Original	0.00	100.00	39.61	32.59
Transformed—(arcsine(square root(original/100)))$^{1.5}$	0.00	1.35	0.7165	0.3360
Percent of students in school eligible for free-reduced price lunch				
Original	0.00	100.00	46.04	28.76
Transformed—arcsine(square root(original/100))	0.00	1.57	0.7406	0.3435

Descriptive Statistics for Questionnaire-Level Variables by Model

Table A-2a
Program Progress

	Percent of Questionnaires	
	Mathematics (N = 6,449)	**Science (N = 8,318)**
Principal Retained in School		
No	25	29
Yes	75	72
Principal Retained in District		
No	19	20
Yes	81	80
Project Year		
0	18	11
1	21	17
2	26	26
3	12	18
4	14	11
5	7	15
6	2	3

Table A-2b
Achievement

	Percent of Questionnaires	
	Mathematics (N = 4,857)	**Science (N = 6,474)**
Principal Retained in School		
No	35	37
Yes	65	64
Principal Retained in District		
No	26	27
Yes	74	74
Project Year		
0	9	7
1	10	10
2	27	17
3	20	23
4	22	18
5	11	21
6	3	4

Table A-2c
Professional Development Activities

	Percent of Questionnaires	
	Mathematics (N = 5,852)	**Science (N = 7,641)**
Principal Retained in School		
No	35	37
Yes	65	63
Principal Retained in District		
No	25	27
Yes	75	74
Project Year		
0	7	6
1	12	11
2	22	15
3	27	24
4	22	24
5	9	18
6	2	3

Table A-2d
Use of LSC Materials

	Percent of Questionnaires	
	Mathematics (N = 5,820)	**Science (N = 7,623)**
Principal Retained in School		
No	35	37
Yes	65	63
Principal Retained in District		
No	26	27
Yes	75	74
Project Year		
0	7	6
1	12	11
2	22	14
3	27	24
4	22	24
5	9	18
6	2	3

Table A-2e
Attitudes Toward Teaching

	Percent of Questionnaires	
	Mathematics (N = 5,509)	**Science (N = 6,802)**
Principal Retained in School		
No	23	26
Yes	77	74
Principal Retained in District		
No	17	18
Yes	83	82
Project Year		
0	20	13
1	21	18
2	30	30
3	9	14
4	13	6
5	6	16
6	2	3

Table A-2f
Principal Support

	Percent of Questionnaires	
	Mathematics (N = 5,701)	**Science (N = 5,503)**
Principal Retained in School		
No	23	29
Yes	77	72
Principal Retained in District		
No	17	20
Yes	83	80
Project Year		
0	20	12
1	21	19
2	29	24
3	9	13
4	13	8
5	6	20
6	2	4

Table A-2g
Principal Support

	Percent of Questionnaires	
	Mathematics (N = 4,492)	**Science (N = 6,078)**
Principal Retained in School		
No	24	26
Yes	76	74
Principal Retained in District		
No	18	18
Yes	83	82
Project Year		
0	20	12
1	18	18
2	29	30
3	10	14
4	14	7
5	7	16
6	3	4

Table A-2h
Descriptive Statistics for Uncollapsed Ordinal Outcome Variables

	Percent of Principals
Mathematics	
Program Progress In Moving Towards Excellence	**(N = 6,449)**
1 of 7 (Quite far from Ideal)	2
2 of 7	2
3 of 7 (Beginning to Improve)	22
4 of 7	17
5 of 7 (Well along in improving)	42
6 of 7	12
7 of 7 (Approaching Ideal)	3
Achievement of Students in this School	**(N = 4,857)**
Much worse	1
Somewhat worse	4
About the same	19
Somewhat improved	51
Much improved	25
Science	
Program Progress In Moving Towards Excellence	**(N = 8,318)**
1 of 7 (Quite far from Ideal)	2
2 of 7	4
3 of 7 (Beginning to Improve)	19
4 of 7	18
5 of 7 (Well along in improving)	40
6 of 7	14
7 of 7 (Approaching Ideal)	4
Achievement of Students in this School	**(N = 6,474)**
Much worse	0
Somewhat worse	3
About the same	22
Somewhat improved	50
Much improved	25

Table A-2i
Descriptive Statistics for Uncollapsed Ordinal Outcome Variables

	Percent of Schools
Mathematics	
Percent of teachers in school involved in LSC PD activities	**(N = 7,641)**
0 Percent	8
10 Percent	9
20 Percent	6
30 Percent	5
40 Percent	3
50 Percent	5
60 Percent	4
70 Percent	6
80 Percent	10
90 Percent	15
100 Percent	29
Percent of teachers implementing at lease some LSC-designated instructional materials	**(N = 7,623)**
0 Percent	8
10 Percent	8
20 Percent	5
30 Percent	5
40 Percent	3
50 Percent	5
60 Percent	4
70 Percent	7
80 Percent	11
90 Percent	13
100 Percent	32
Science	
Percent of teachers in school involved in LSC PD activities	**(N = 7,641)**
0 Percent	7
10 Percent	8
20 Percent	6
30 Percent	5
40 Percent	4
50 Percent	6
60 Percent	4
70 Percent	7
80 Percent	10
90 Percent	13
100 Percent	30
Percent of teachers implementing at lease some LSC-designated instructional materials	**(N = 7,623)**
0 Percent	7
10 Percent	6
20 Percent	5
30 Percent	4
40 Percent	3
50 Percent	6
60 Percent	4
70 Percent	7
80 Percent	10
90 Percent	14
100 Percent	32