LSC Classroom Observation Study: An Analysis of Data Collected Between 1998 and 2003

by

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INTRODUCTION

In 1995 the National Science Foundation initiated the Local Systemic Change (LSC) through Teacher Enhancement program to improve instruction in science, mathematics, and technology. Through the LSC program, 88 individual projects were funded, typically in 1 of 4 targeted areas—K–8 science, K–8 mathematics, 6–12 mathematics, or 6–12 science—though some projects targeted 2 of these 4 areas (e.g., K–12 mathematics or K–8 science and mathematics). LSC projects were expected to provide 130 hours of professional development to each targeted teacher over the course of its funding, with the emphasis on preparing teachers to implement exemplary science and mathematics instructional materials and lessons in their classes.[1]

As part of the core evaluation, the evaluators of each LSC project were required to observe a single lesson of a random sample of teachers targeted by their project.[2] Evaluators utilized a common instrument for rating the features and quality of the observed sessions, the Classroom Observation Protocol (COP). The accumulated protocols provide a large set of data on the nature and quality of classroom instruction across the LSC, and allow for an examination of the impact of the LSC program on classroom instruction. Specifically, the questions that can be investigated with these data are:

- Is use of and adherence to the LSC-designated instructional materials related to lesson quality?
- Does teacher participation in LSC professional development predict lesson quality?

A series of hierarchical generalized linear models (HGLM), with lessons nested within projects, was used to assess the relationships between a number of aspects of observed lesson quality and both teacher participation in LSC professional development, and the use of LSC-designated instructional materials. Because research on a national sample of mathematics and science lessons has shown that certain indicators on the observation protocol are highly predictive of overall lesson quality,[3] this study examines these key indictors in addition to the overall rating of lesson quality (the "capsule rating"). The outcomes examined in this study are:

- Capsule rating (overall quality of the lesson);
- The degree to which the mathematics/science content was significant and worthwhile;
- The degree to which the mathematics/science content was appropriate for the developmental levels of the students in this class;

[1] Prior to 1999, the requirement for K–8 projects was 100 hours.

[2] Evaluators were required to attend training on the use of the observation protocol to ensure consistent application of the rating scales across projects.

[3] Weiss, I.R., Pasley, J.D., Smith, P.S., Banilower, E.R., & Heck, D.J. (2003). *Looking inside the classroom: A Study of K–12 mathematics and science education in the United States*. Chapel Hill, NC: Horizon Research, Inc.

- The degree to which mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification;

- The degree to which the teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving;

- The degree to which active participation of all was encouraged and valued;

- The degree to which there was a climate of respect for student's ideas, questions, and contributions;

- The degree to which students were intellectually engaged with important ideas relevant to the focus of the lesson;

- The degree to which intellectual rigor, constructive criticism, and the challenging of ideas were evident; and

- The degree to which the "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.

This study utilizes cross-sectional classroom observation and teacher questionnaire data collected from the LSC projects to date.

SAMPLE

Between 1998 and 2003, 3,511 classroom observations were conducted as part of the LSC core evaluation. A number of observations were excluded from this analysis for a variety of reasons. Observations of lessons taught by teacher leaders, who are not representative of the typical teacher targeted by the LSCs, were removed, reducing the data set by 414 cases. The sample was further reduced by 1,017 cases due to missing school or teacher questionnaire data. Finally, in order to avoid shared variance among multiple lessons taught by the same teacher and maintain independent samples across the treatment level groups, when a teacher was observed multiple times, a single observation was randomly selected to be included in this analysis, which reduced the sample by 470 observations. The resulting data set includes 1,610 lesson observations, though the number of cases varies among the analyses due to different patterns of missing data on each outcome variable.

Chi-square tests were performed to compare the distributions of key variables in the original data set and the final data set used in the analyses. The distributions of each outcome variable and teacher use of/adherence to the LSC-designated instructional materials were essentially equivalent in the two data sets. The only significant difference was in the distribution of professional development hours, with the final data set having a slightly lower proportion of teachers in the high treatment categories than the original data set. Having fewer highly treated

teachers in the data set is likely to reduce the probability of detecting a significant impact of the LSC by the extent of teacher participation in professional development. Thus these analyses are likely relatively conservative. Exact chi-square test statistics for these comparisons can be found in Appendix A.

It is important to note that teacher participation in the LSC program and in the core evaluation is voluntary. Although teachers are randomly sampled for classroom observations, it is not unusual for teachers to decline to be observed. An analysis of project-provided treatment level of teachers indicates that teachers that agreed to be observed tend to have higher levels of participation in LSC professional development than teachers who declined to be observed (see Table 1). Thus, the results of these analyses should be interpreted with some caution.

Table 1
Treatment Levels of Sampled Teachers, by Response

	Percent of Teachers	
	Yes	**No**
0 hours	17	32
1–19 hours	8	10
20–59 hours	19	16
60–99 hours	22	11
100–129 hours	14	15
130–159 hours	7	8
160–199 hours	5	4
200 or more hours	8	4

The 1,610 observations in the final data set for this study included data from lessons in 85 LSC projects. Table 2 shows the distribution of lessons in the sample by subject and grade-range, as well as the number of projects targeting each subject/grade-range.

Table 2
Observed Lessons and Projects
Included in Analyses, by Grade-Range/Subject

	Number of Projects	Percent of Projects	Number of Observed Lessons	Percent of Observed Lessons
K–8 Science	45	45	654	41
K–8 Mathematics	29	29	533	33
6–12 Mathematics	19	19	322	20
6–12 Science	7	7	101	6
Total	**85**[†]	**100**	**1,610**	**100**

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

ANALYSIS AND RESULTS

Lessons observed by LSC evaluators are given a capsule rating on the classroom observation protocol using a seven-point scale. In order to improve the stability of the estimates in these analyses, and to facilitate interpretation of results, the scale for the capsule rating was collapsed to three points. The ratings of key indicators were collapsed from a five-point scale to three points for the same purpose. Table 3 presents the frequencies for classroom observation capsule ratings and the other outcome variables included in these analyses. Roughly equal number of lessons received low, medium, and high capsule ratings; the ratings on the other outcomes are distributed less evenly.

Table 3
Classroom Observation Protocol Ratings for Key Outcomes

	Number of Lessons	Percent of Lessons		
		Low	Medium	High
Capsule rating	1,610	33	36	30
The mathematics/science content was significant and worthwhile	1,610	15	22	63
The mathematics/science content was appropriate for the developmental levels of the students in this class	1,600	12	21	66
Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification	1,597	17	21	62
The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving	1,582	13	23	64
Active participation of all was encouraged and valued	1,596	31	29	40
There was a climate of respect for student's ideas, questions, and contributions	1,582	39	25	36
Students were intellectually engaged with important ideas relevant to the focus of the lesson	1,512	41	24	35
Intellectual rigor, constructive criticism, and the challenging of ideas were evident	1,501	46	22	32
The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson	1,502	44	25	32

The LSC classroom observation data have a nested structure; there are multiple observed lessons within each LSC project. 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[4]).

A two-level hierarchical model (lessons nested within projects) was used to investigate the relationship between each of the outcome variables and the extent of teacher participation in LSC

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

professional development. Also, this model was used to study the relationship between each outcome variable and the use of the LSC-designated instructional materials in lessons. A number of teacher and school demographic factors were controlled in this model, including the number of students enrolled in the school and the type of community in which the school is located. As the number of lessons in the data set from any one school was small, most often only one, it was not appropriate to include a separate school level in the model; school-level variables (i.e., school demographics) were entered at the lesson level.

The predictor variables included at the lesson level were:

- Extent of teacher participation in LSC professional development at the time of observation;
- Whether the lesson was based upon the LSC-designated instructional materials and, if so, how closely the lesson design adhered to the instructions provided in the teacher's manual;
- Teacher experience level;
- Teacher perception of principal support;
- Number of students enrolled in the school;
- Proportion of students in the school classified as non-Asian minority;
- Proportion of students in the school eligible for free/reduced-price lunch;
- Proportion of students in the school classified as limited-English proficient; and
- Type of community in which the school is located.

At the project level, the following predictors were included:

- Number of teachers targeted by the LSC; and
- Subject/grade-range targeted by the LSC.

Regression analysis assumes that the variables utilized are multivariate normal. Because a number of variables deviated substantially from a normal distribution, each was transformed in an attempt to normalize their distributions. Descriptive statistics for the independent variables used in the model are shown in Tables 4 and 5, including descriptives on original and transformed variables when applicable.

Slightly more than half of the observed lessons were based on the LSC-designated instructional materials. The extent to which teachers had participated in LSC professional development varied widely. Thirty percent had not yet participated in LSC professional development at the time their classroom was observed, 27 percent had participated in 1–39 hours, 17 percent had participated in 40–79 hours, and 26 percent had participated in 80 or more hours of LSC professional development. Roughly half of the teachers in the sample had 11 or more years of prior teaching experience, while about one-third had taught for 5 or fewer years.

Nearly half of the observed lessons took place in schools located in urban areas, about one-fourth in schools in suburban communities, with the remainder roughly divided between schools in rural areas and towns/small cities. School size varied widely, with the smallest school enrolling 33 students and the largest over 3,000 students. On average, 45 percent of the students in these

schools belonged to a non-Asian minority group and 47 percent were eligible for free/reduced-price lunch. About one quarter of the observations occurred in schools with no students classified as limited-English proficient (LEP); 8 percent of observations occurred in schools where over 50 percent of the students were classified as LEP.

Table 4
Descriptive Statistics for Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.04	14.08
Transformed—Squared (in thousands)	0.40	10.00	6.00	2.05
Number of students in school				
Original	33.00	3,250.00	731.44	435.00
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.29	34.71
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.41	32.14
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table 5
Descriptive Statistics for Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Level of adherence to LSC-designated instructional materials	
Not Used	47
Low	14
Medium	16
High	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

The descriptive statistics presented above are representative of the full dataset. Due to different patterns of missing data, the descriptives for the final datasets used for the different outcome variables vary slightly. Descriptive statistics for the dataset used in each outcome variable analysis can be found in Appendix B.

The outcome variables for the analyses are ordinal variables. For these analyses, the lesson is conceptualized as an event with an underlying distribution of probabilities that its rating will be in each category. The analysis produces estimates of the likelihood that a lesson will be rated in each category based on the extent of the teacher's participation in LSC professional development and level of adherence to the LSC-designated instructional materials, 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 variables were organized as follows:

Y_{ij} = X = Rating of outcome variable for lesson i in project j
X = L = Rating in Low category
X = M = Rating in Medium category
X = H = Rating in High category

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

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

$$\varphi_{Lij} = \varphi^{*}_{Lij}$$
$$\varphi_{Mij} + \varphi_{Lij} = \varphi^{*}_{Mij}$$
$$\varphi_{Hij} + \varphi_{Mij} + \varphi_{Lij} = \varphi^{*}_{Hij} = 1$$

The expected value and variance for each category of the ordinal outcome variables 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 2 values in model:

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

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

Using this transformation, η_{Xij} is the logarithm of the predicted odds (or "log-odds") of a lesson being rated in or below category X. Since the estimated outcomes are the log odds of a capsule rating in or below each category, the predicted probability of a rating in or below each category for any teacher 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 a rating in each category can be computed.

HLM 5.05[5] was used for all analyses. All independent variables were entered using grand-mean centering; categorical variables were entered as sets of dummy-coded variables. The level 2 random effect for each predictor variable was tested, and included in the model when significant (i.e., when the relationship between the lesson-level variable and the outcome varied significantly across projects). The exact model for each outcome variable analysis can be found in Appendix C.

One current software limitation of estimating hierarchical generalized linear models is the inability to use sample design weights. However, the lack of random variation across projects for any of the variables included at the lesson level suggests that the unweighted data provide reasonable estimates, despite the unequal sampling probabilities of lessons in projects of different size.

The general model used for each outcome variable is detailed below.

Level 1

η_{Lij} = B_0
+ B_1*(LSC materials used – low adherence)
+ B_2*(LSC materials used – medium adherence)
+ B_3*(LSC materials used – high adherence)
+ B_4*(Community Type: Rural)
+ B_5*(Community Type: Town or Small City)
+ B_6*(Community Type: Suburban)
+ B_7*(Arcsine of the Square Root of Non-Asian Minority)
+ B_8*(Arcsine of the Square Root of Free/Reduced-Price Lunch)
+ B_9*(Squared Teacher's Perception of Principal Support (in thousands))

[5] Raudenbush, S. W., Bryk, A. S., & Congdon, R. T. (2004). HLM (Version 6.0) [Computer software]. Lincolnwood, IL: Scientific Software International, Inc.

+ B_{10}*(Number of Hours of LSC Professional Development: 1-19 Hours)
+ B_{11}*(Number of Hours of LSC Professional Development: 20-39 Hours)
+ B_{12}*(Number of Hours of LSC Professional Development: 40-79 Hours)
+ B_{13}*(Number of Hours of LSC Professional Development: 80 or More Hours)
+ B_{14}*(Natural Log of the Number of Students)
+ B_{15}*(Experience Level: 0-5 Years)
+ B_{16}*(Experience Level: 11 or More Years)
+ B_{17}*(Limited English Proficient: 1-25 Percent)
+ B_{18}*(Limited English Proficient: 26-50 Percent)
+ B_{19}*(Limited English Proficient: More than 50 Percent)

η_{Mij} = B_0
+ B_1*(LSC materials used – low adherence)
+ B_2*(LSC materials used – medium adherence)
+ B_3*(LSC materials used – high adherencel)
+ B_4*(Community Type: Rural)
+ B_5*(Community Type: Town or Small City)
+ B_6*(Community Type: Suburban)
+ B_7*(Arcsine of the Square Root of Non-Asian Minority)
+ B_8*(Arcsine of the Square Root of Free/Reduced-Price Lunch)
+ B_9*(Squared Teacher's Perception of Principal Support (in thousands))
+ B_{10}*(Number of Hours of LSC Professional Development: 1-19 Hours)
+ B_{11}*(Number of Hours of LSC Professional Development: 20-39 Hours)
+ B_{12}*(Number of Hours of LSC Professional Development: 40-79 Hours)
+ B_{13}*(Number of Hours of LSC Professional Development: 80 or More Hours)
+ B_{14}*(Natural Log of the Number of Students)
+ B_{15}*(Experience Level: 0-5 Years)
+ B_{16}*(Experience Level: 11 or More Years)
+ B_{17}*(Limited English Proficient: 1-25 Percent)
+ B_{18}*(Limited English Proficient: 26-50 Percent)
+ B_{19}*(Limited English Proficient: More than 50 Percent)
+ d(2)

Level 2

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$

$B_{16} = G_{160}$
$B_{17} = G_{170}$
$B_{18} = G_{180}$
$B_{19} = G_{190}$

The results for these models are shown in Tables 6a and 6b. Due to the transformation of the outcome variable and the centering of dummy-coded predictor variables, the magnitude and direction of these coefficients should not be interpreted directly. The coefficients must be converted to probabilities in order to draw meaningful interpretations and conclusions.

Table 6a
Fixed Effects and Standard Errors for Final Models[†]

	Capsule Rating	Significant and worthwhile content	Appropriate content	Active participation encouraged	Climate of respect
Intercept	-1.20***	-2.46***	-2.52***	-2.14***	-1.79***
	(0.21)	(0.25)	(0.25)	(0.24)	(0.23)
Threshold	1.77***	1.42***	1.42***	1.30***	1.17***
	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)
School Characteristics					
Number of Students	0.11	-0.34**	-0.13	0.03	0.11
	(0.10)	(0.12)	(0.12)	(0.11)	(0.11)
Non-Asian Minority	0.27	0.83***	0.77**	0.56**	0.56**
	(0.19)	(0.22)	(0.21)	(0.21)	(0.21)
Limited-English Proficient (0 percent omitted)					
1–25 percent	0.20	0.17	0.14	0.11	0.32*
	(0.12)	(0.14)	(0.14)	(0.14)	(0.14)
26–50 percent	0.20	0.50*	0.42*	0.11	0.03
	(0.19)	(0.21)	(0.20)	(0.20)	(0.20)
More than 50 percent	0.21	0.80**	0.36	0.41~	0.41~
	(0.22)	(0.24)	(0.24)	(0.23)	(0.23)
Free/Reduced-Price Lunch	0.47*	-0.30	-0.14	0.13	0.05
	(0.21)	(0.24)	(0.24)	(0.23)	(0.23)
Community Type (Urban omitted)					
Rural	0.28	0.00	0.03	-0.18	0.12
	(0.18)	(0.21)	(0.21)	(0.20)	(0.20)
Suburban	0.16	0.22	0.33*	0.04	0.02
	(0.13)	(0.15)	(0.15)	(0.15)	(0.15)
Town or Small City	0.07	-0.03	-0.12	0.12	0.04
	(0.15)	(0.18)	(0.18)	(0.17)	(0.17)
Teacher Characteristics					
Experience Level (Intermediate omitted)					
Novice (0–5 yr)	0.38**	0.26	0.45**	0.19	0.18
	(0.14)	(0.16)	(0.16)	(0.16)	(0.16)
Very Experienced (11+ yr)	0.29*	0.13	0.31*	0.19	0.32*
	(0.13)	(0.15)	(0.15)	(0.15)	(0.15)
Teacher's Perceptions of Principal Support	-0.06*	0.00	0.00	-0.02	-0.04~
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Number of Hours of LSC PD (0 hours omitted)					
1–19 hours	-0.23	-0.08	-0.15	0.06	-0.17
	(0.15)	(0.17)	(0.17)	(0.16)	(0.16)
20–39 hours	-0.73***	-0.54**	-0.56**	-0.33~	-0.51**
	(0.17)	(0.20)	(0.19)	(0.19)	(0.19)
40–79 hours	-0.44**	-0.58**	-0.45**	-0.41*	-0.34*
	(0.15)	(0.17)	(0.17)	(0.16)	(0.16)
80 or more hours	-0.47**	-0.29~	-0.37*	-0.38*	-0.46**
	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)
LSC-Designated Instructional Materials Used in Lesson ("LSC Materials Not Used" omitted)					
Low adherence	0.39*	0.26~	0.11	0.36*	0.51**
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
Medium adherence	-1.00***	-1.07***	-0.97***	-0.49**	-0.34*
	(0.14)	(0.18)	(0.17)	(0.16)	(0.16)
High adherence	-1.32***	-1.42***	-1.32***	-0.81***	-0.74***
	(0.13)	(0.18)	(0.17)	(0.16)	(0.16)

~ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[†] Due to space limitations, project level predictors were left out of this table. None were significant predictors of the outcomes.

Table 6b
Fixed Effects and Standard Errors for Final Models†

	Students intellectually engaged	Effective teacher questioning strategies	Mathematics/ science portrayed as dynamic body of knowledge	Intellectual rigor evident	Appropriate sense-making
Intercept	-1.14***	-1.03***	-0.73**	-0.73**	-0.43˜
	(0.21)	(0.22)	(0.22)	(0.22)	(0.22)
Threshold	1.36***	1.14***	1.15***	1.16***	1.03***
	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)
School Characteristics					
Number of Students	0.12	0.10	-0.01	0.08	0.19˜
	(0.10)	(0.11)	(0.11)	(0.11)	(0.11)
Non-Asian Minority	0.54**	0.35˜	0.14	0.50*	0.40˜
	(0.19)	(0.20)	(0.20)	(0.20)	(0.21)
Limited-English Proficient (0 percent omitted)					
1–25 percent	0.17	0.15	0.15	0.05	0.26*
	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)
26–50 percent	0.01	0.35˜	-0.05	0.09	0.45*
	(0.19)	(0.19)	(0.20)	(0.20)	(0.20)
More than 50 percent	0.21	0.43˜	0.32	0.21	0.51*
	(0.22)	(0.23)	(0.23)	(0.24)	(0.24)
Free/Reduced-Price Lunch	0.05	0.21	0.39˜	0.24	0.06
	(0.21)	(0.22)	(0.22)	(0.22)	(0.22)
Community Type (Urban omitted)					
Rural	0.05	0.08	0.27	0.25	0.22
	(0.18)	(0.19)	(0.19)	(0.19)	(0.19)
Suburban	0.05	0.21	0.09	0.19	0.28˜
	(0.13)	(0.14)	(0.14)	(0.14)	(0.14)
Town or Small City	-0.10	-0.09	-0.12	-0.09	0.23
	(0.15)	(0.16)	(0.16)	(0.16)	(0.16)
Teacher Characteristics					
Experience Level (Intermediate omitted)					
Novice (0–5 yr)	0.42**	0.31*	0.35*	0.42**	0.30*
	(0.14)	(0.15)	(0.15)	(0.15)	(0.15)
Very Experienced (11+ yr)	0.42**	0.29*	0.17	0.27*	0.24˜
	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)
Teacher's Perceptions of Principal Support	-0.05*	-0.04˜	-0.03	-0.04˜	-0.06*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Number of Hours of LSC PD (0 hours omitted)					
1-19 Hours	-0.23	-0.14	-0.16	-0.19	0.04
	(0.15)	(0.16)	(0.16)	(0.16)	(0.17)
20-39 Hours	-0.74***	-0.52**	-0.62**	-0.56**	-0.63**
	(0.17)	(0.17)	(0.17)	(0.17)	(0.18)
40-79 Hours	-0.42**	-0.54**	-0.51**	-0.43**	-0.44**
	(0.15)	(0.15)	(0.16)	(0.15)	(0.16)
80 or more Hours	-0.39**	-0.45**	-0.49**	-0.33*	-0.32*
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
LSC-designated Instructional Materials Used in Lesson (Not Used omitted)					
Low adherence	0.37*	0.32*	0.19	0.28˜	0.54**
	(0.15)	(0.15)	(0.16)	(0.16)	(0.17)
Medium Adherence	-0.75***	-0.81***	-0.93***	-0.71***	-0.67***
	(0.14)	(0.14)	(0.15)	(0.15)	(0.15)
High adherence	-1.09***	-1.12***	-1.37***	-1.00***	-0.99***
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)

˜ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

† Due to space limitations, project level predictors were left out of this table. None were significant predictors of the outcomes.

Table 7 provides the predicted probabilities of a lesson being rated low, medium, and high on each outcome by teacher participation in LSC professional development. Four patterns emerge from these data. First, for each indicator, lessons taught by teachers with 20 or more hours of LSC professional development have a greater probability of receiving a high rating than those taught by teachers who have not yet participated in LSC professional development. For example, lessons taught by teachers in the 0 hours group have a predicted probability of 0.29 of receiving a 4 (Accomplished, Effective Instruction) or 5 (Exemplary Instruction) on the capsule rating, compared to predicted probabilities of 0.46 for lessons taught by those with 20–39 hours, 0.39 for lessons taught by those with 40–79 hours, and 0.39 for lessons taught by those with more than 80 hours. The predicted probability of a lesson receiving a 4 or 5 (To a Great Extent) rating on the indicator "mathematics/science was portrayed as a dynamic body of knowledge" ranges from 0.42 to 0.44 for lessons of teachers with 20 or more hours of LSC professional development, compared to a predicted probability of 0.32 for lessons by teachers in the 0 hours group.

The second pattern that emerges from the data is that beyond 20–39 hours of LSC professional development, there appears to be little increase in the probability of a lesson or a key indicator being rated highly. This pattern is seen for all of the outcomes studied. For example, on the "active participation of all was encouraged and valued" indicator, lessons taught by teachers in the 0 hours group have a predicted probability of 0.65 of being highly rated, compared to probabilities of 0.73, 0.74, and 0.74 for the 20–39 hours, 40–79 hours, and 80 or more hours groups, respectively.

Third, on four of the indicators the predicted probability of a lesson receiving a high rating is much greater than 50 percent, regardless of the amount of treatment the teacher has received. These indicators are:

- Mathematics/science content was significant and worthwhile;
- Mathematics/science content was appropriate for the developmental levels for the students in the class;
- Active participation of all was valued and encouraged; and
- There was a climate of respect for students' ideas, questions, and contributions.

In contrast, three of the indicators examined in this study were more likely to be rated low or medium, an indication that teachers still struggle with these facets of instruction even after substantial amounts of LSC professional development. These three indicators are:

- Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification;
- Intellectual rigor, constructive criticism, and the challenging of ideas were evident; and
- The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.

Table 7
Predicted Probability of a Lesson Receiving a Rating in Each Category, by Hours of LSC Professional Development

	Predicted Probability				
	0	**1–19**	**20–39**	**40–79**	**80 or More**
Capsule rating					
Low	0.29	0.25	0.17	0.21	0.21
Medium	0.42	0.41	0.37	0.40	0.40
High	0.29	0.34	0.46	0.39	0.39
Significant and worthwhile content					
Low	0.10	0.09	0.06	0.06	0.08
Medium	0.21	0.20	0.15	0.14	0.18
High	0.69	0.71	0.79	0.80	0.75
Developmentally appropriate content					
Low	0.09	0.08	0.06	0.06	0.07
Medium	0.21	0.19	0.14	0.15	0.16
High	0.70	0.73	0.80	0.78	0.77
Mathematics/science portrayed as a dynamic body of knowledge					
Low	0.40	0.36	0.26	0.28	0.29
Medium	0.28	0.28	0.27	0.27	0.27
High	0.32	0.36	0.47	0.44	0.44
Teacher's questioning strategies likely to enhance student understanding/problem solving					
Low	0.32	0.29	0.22	0.22	0.23
Medium	0.28	0.27	0.25	0.25	0.26
High	0.40	0.43	0.53	0.53	0.51
Active participation of all encouraged and valued					
Low	0.13	0.13	0.09	0.09	0.09
Medium	0.22	0.23	0.18	0.17	0.17
High	0.65	0.64	0.73	0.74	0.74
Climate of respect for student's ideas, questions, and contributions					
Low	0.18	0.15	0.12	0.13	0.12
Medium	0.23	0.22	0.18	0.20	0.19
High	0.59	0.63	0.70	0.67	0.69
Students intellectually engaged					
Low	0.30	0.25	0.17	0.22	0.23
Medium	0.32	0.32	0.27	0.30	0.31
High	0.38	0.43	0.56	0.48	0.47
Intellectual rigor, constructive criticism, and the challenging of ideas evident					
Low	0.38	0.34	0.26	0.29	0.31
Medium	0.28	0.28	0.27	0.28	0.28
High	0.34	0.38	0.47	0.44	0.41
Appropriate "sense-making"					
Low	0.45	0.46	0.30	0.35	0.37
Medium	0.25	0.24	0.25	0.25	0.25
High	0.30	0.30	0.45	0.40	0.38

The other independent variable of main interest in this study is whether the lesson was based on the LSC-designated instructional materials, and if so, to what extent the lesson adhered to the instructions provided in the teacher's manual. Table 8 provides predicted probabilities for each outcome variable by this variable. For all indicators except climate of respect for students' ideas, questions and contributions, lessons using LSC-designated materials with medium or high adherence to the instructions in the teacher's manual have a significantly higher probability of being highly rated than lessons not using LSC-designated materials. However, lessons not using LSC-designated materials are more likely to be highly rated than those using the LSC-designated materials with low adherence.

Table 8
Predicted Probability of a Lesson Receiving a Rating in Each Category, by Use of LSC Materials

	LSC Materials Not Used	LSC Materials Used		
		Low Adherence	Medium Adherence	High Adherence
Capsule rating				
Low	0.31	0.40	0.14	0.11
Medium	0.42	0.40	0.35	0.31
High	0.27	0.20	0.51	0.59
Significant and worthwhile content				
Low	0.12	0.15	0.04	0.03
Medium	0.24	0.27	0.11	0.09
High	0.64	0.58	0.84	0.88
Developmentally appropriate content				
Low	0.11	0.12	0.04	0.03
Medium	0.23	0.24	0.12	0.09
High	0.66	0.64	0.84	0.88
Mathematics/science portrayed as a dynamic body of knowledge				
Low	0.42	0.47	0.22	0.16
Medium	0.28	0.27	0.25	0.21
High	0.30	0.26	0.52	0.63
Teacher's questioning strategies likely to enhance student understanding/problem solving				
Low	0.33	0.41	0.18	0.14
Medium	0.28	0.28	0.23	0.20
High	0.39	0.32	0.59	0.66
Active participation of all encouraged and valued				
Low	0.13	0.17	0.08	0.06
Medium	0.22	0.26	0.16	0.13
High	0.65	0.57	0.75	0.81
Climate of respect for student's ideas, questions, and contributions				
Low	0.16	0.24	0.12	0.08
Medium	0.22	0.27	0.19	0.14
High	0.62	0.49	0.69	0.77
Students intellectually engaged				
Low	0.30	0.39	0.17	0.13
Medium	0.33	0.32	0.27	0.23
High	0.37	0.29	0.56	0.64
Intellectual rigor, constructive criticism, and the challenging of ideas evident				
Low	0.39	0.46	0.24	0.19
Medium	0.28	0.27	0.26	0.24
High	0.33	0.27	0.50	0.57
Appropriate "sense-making"				
Low	0.45	0.59	0.30	0.24
Medium	0.24	0.21	0.24	0.23
High	0.30	0.20	0.46	0.53

Table 9 shows the relationship between lesson ratings and the combination of professional development and use of the LSC-designated instructional materials. Three results are evident from these data. First, as mentioned previously, lessons are more likely to be rated highly when

they are based on and adhere to the LSC-designated instructional materials. This pattern is consistent across the various levels of professional development. For example, on the intellectual engagement indicator, a lesson taught by an untreated teacher using the LSC-designated materials with high adherence has a 0.57 probability of being rated highly, compared to a 0.31 probability for lessons not using those materials.

Table 9
Predicted Probability of a Lesson Receiving a Rating in High Category, by Hours of LSC Professional Development and Use of LSC-Designated Instruments

	Predicted Probability				
	0 Hours	1–19 Hours	20–39 Hours	40–79 Hours	80 or More Hours
Capsule Rating					
Did not use LSC materials	0.22	0.26	0.36	0.30	0.30
Used LSC materials-low adherence	0.16	0.19	0.28	0.23	0.23
Used LSC materials-medium adherence	0.43	0.48	0.61	0.54	0.54
Used LSC materials-high adherence	0.51	0.56	0.68	0.62	0.62
Significant and worthwhile content					
Did not use LSC materials	0.59	0.61	0.71	0.72	0.65
Used LSC materials-low adherence	0.52	0.54	0.65	0.66	0.59
Used LSC materials-medium adherence	0.80	0.82	0.88	0.88	0.85
Used LSC materials-high adherence	0.85	0.86	0.91	0.91	0.89
Developmentally appropriate content					
Did not use LSC materials	0.60	0.63	0.73	0.70	0.68
Used LSC materials-low adherence	0.57	0.61	0.70	0.68	0.66
Used LSC materials-medium adherence	0.80	0.82	0.87	0.86	0.85
Used LSC materials-high adherence	0.85	0.87	0.91	0.90	0.89
Mathematics/science portrayed as a dynamic body of knowledge					
Did not use LSC materials	0.24	0.27	0.37	0.34	0.34
Used LSC materials-low adherence	0.21	0.23	0.33	0.30	0.30
Used LSC materials-medium adherence	0.44	0.48	0.60	0.57	0.57
Used LSC materials-high adherence	0.55	0.59	0.70	0.67	0.67
Teacher's questioning strategies likely to enhance student understanding/problem solving					
Did not use LSC materials	0.32	0.35	0.45	0.45	0.43
Used LSC materials-low adherence	0.26	0.28	0.37	0.37	0.35
Used LSC materials-medium adherence	0.52	0.55	0.64	0.65	0.63
Used LSC materials-high adherence	0.59	0.63	0.71	0.71	0.70
Active participation of all encouraged and valued					
Did not use LSC materials	0.61	0.59	0.68	0.70	0.69
Used LSC materials-low adherence	0.52	0.50	0.60	0.62	0.61
Used LSC materials-medium adherence	0.72	0.70	0.78	0.79	0.79
Used LSC materials-high adherence	0.78	0.76	0.83	0.84	0.84
Climate of respect for student's ideas, questions, and contributions					
Did not use LSC materials	0.55	0.59	0.67	0.63	0.66
Used LSC materials-low adherence	0.43	0.47	0.55	0.51	0.54
Used LSC materials-medium adherence	0.63	0.67	0.74	0.71	0.73
Used LSC materials-high adherence	0.72	0.75	0.81	0.78	0.80
Students intellectually engaged					
Did not use LSC materials	0.31	0.36	0.48	0.40	0.39
Used LSC materials-low adherence	0.23	0.28	0.39	0.32	0.31
Used LSC materials-medium adherence	0.48	0.54	0.66	0.59	0.58
Used LSC materials-high adherence	0.57	0.62	0.73	0.67	0.66
Intellectual rigor, constructive criticism, and the challenging of ideas evident					
Did not use LSC materials	0.27	0.31	0.40	0.37	0.34
Used LSC materials-low adherence	0.22	0.26	0.33	0.30	0.28
Used LSC materials-medium adherence	0.43	0.48	0.57	0.54	0.51
Used LSC materials-high adherence	0.51	0.55	0.64	0.61	0.59
Appropriate "sense-making"					
Did not use LSC materials	0.25	0.25	0.39	0.35	0.32
Used LSC materials-low adherence	0.17	0.16	0.27	0.24	0.21
Used LSC materials-medium adherence	0.40	0.39	0.56	0.51	0.48
Used LSC materials-high adherence	0.48	0.47	0.63	0.59	0.56

Second, regardless of use of the LSC-designated instructional materials, lessons of teachers with at least 20 hours of professional development tend to be rated more highly than lessons of teachers who have not yet participated in LSC professional development. For example, on the intellectual rigor indicator, a lesson using the LSC-designated instructional materials with high adherence taught by a teacher in the 20–39 hours group has a 0.64 probability of being highly rated, compared to a probability of 0.51 for a teacher in the 0 hours group also using the LSC-designated instructional materials with high adherence. Similarly, on the teacher questioning strategies indicator, a lesson taught without the LSC materials by a teacher with 20–39 hours of treatment has a 0.45 probability of being highly rated, while one taught by a teacher with no participation in LSC professional development has a probability of 0.32.

Third, the combination of treatment and adherence to the LSC-designated instructional materials results in an even higher probability of a lesson being rated highly. For example, a lesson taught by a teacher with 0 hours of participation in LSC professional development and not using the LSC-designated materials has a 0.61 probability of receiving a high rating on the "active participation" indicator; a lesson taught by a teacher with 80 or more hours of LSC professional development and using the LSC-designated instructional materials with high adherence has a 0.84 probability of being rated high on this indicator. (See Figure 1.)

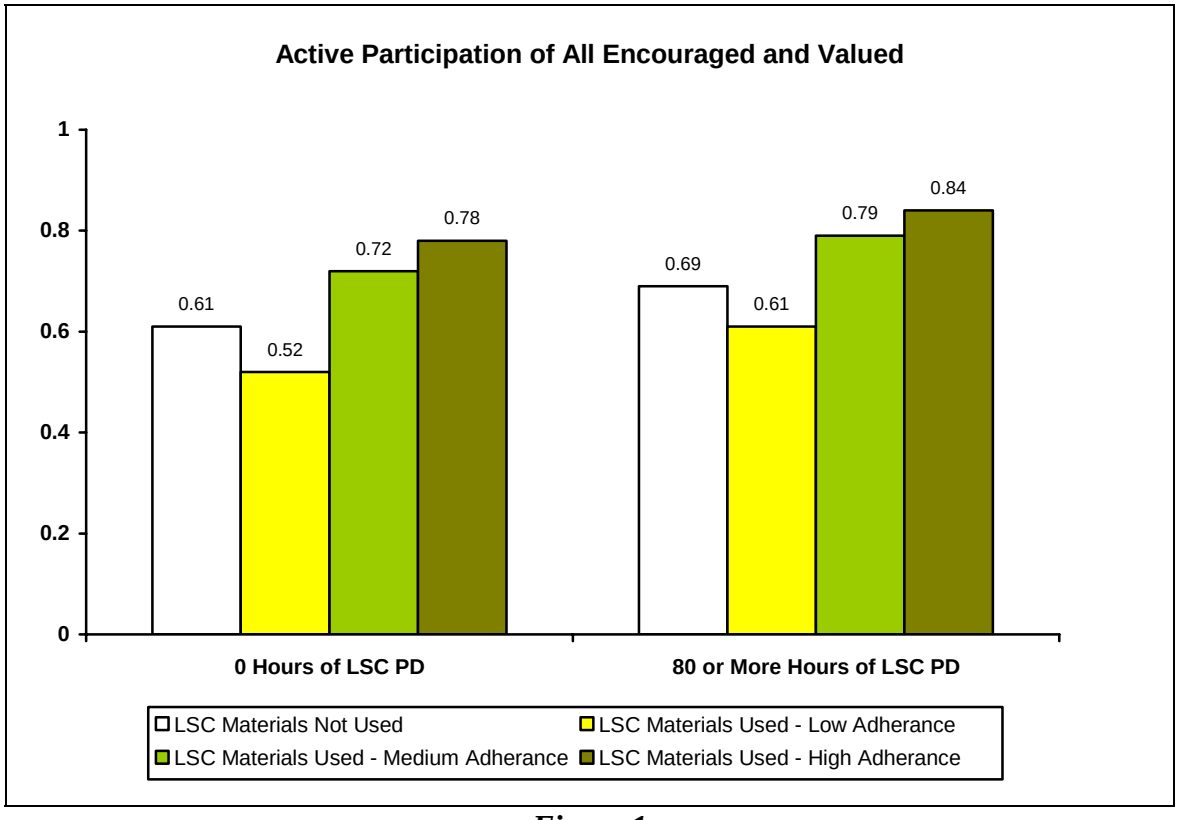

Figure 1

Two other findings of interest emerged from these analyses. First, lessons by teachers who perceive higher levels of principal support are more likely to receive a high capsule rating. Second, lessons observed in schools with higher percentages of non-Asian minority students were more likely to be rated in the low category for the capsule rating as well as on each of the key indicators.

CONCLUSIONS

The extent of teachers' participation in LSC professional development was a positive and significant predictor of evaluator ratings of the quality of observed lessons as measured by the capsule rating and a number of key indicators. The impact of professional development is more pronounced 0–20 hours.

Whether and how teachers use the LSC-designated instructional materials was also a significant predictor of ratings. Lessons taught by teachers using and adhering to the LSC-designated instructional materials were more likely to receive higher ratings on the capsule rating and key indicators. However, those lessons in which teachers heavily modified the LSC-designated instructional materials were less likely to receive high ratings than teachers who did not use those materials at all.

These findings suggest that two fundamental features of the LSC program—implementation of exemplary designated instructional materials as designed and teacher professional development grounded in the appropriate use of those materials—are having a positive effect on classroom instruction in science and mathematics. However, both of these relationships were moderate. It is quite possible that other, unmeasured factors may explain additional variation in lesson ratings.

The findings from this study are encouraging, but some caution is needed in their interpretation. Due to the large number of evaluators, inter-rater reliability was an issue for classroom observation data. In addition, teacher participation in LSC professional development is voluntary, and the danger of selection bias in the sample does exist. Also, this study was cross-sectional in nature so there are limitations in the design of this study. Still, recognizing the limits of this study, the results are promising and appear to suggest that the LSC program is having the intended impacts on teachers' classroom practice.

Appendix A

Chi-Square Tests Comparing the Distributions of Key Variables in the Original and Final Data Sets

Table A-1
Chi-Square Tests Comparing the Distributions of Key Variables in the Original and Final Data Sets

	Chi-Square		
	value	**df**	**p**
Capsule rating	0.461	2	0.794
The mathematics/science content was significant and worthwhile	0.436	2	0.804
The mathematics/science content was appropriate for the developmental levels of the students in this class	0.016	2	0.992
Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification	0.400	2	0.819
The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving	0.382	2	0.826
Active participation of all was encouraged and valued	0.090	2	0.956
There was a climate of respect for student's ideas, questions, and contributions	0.738	2	0.691
Students were intellectually engaged with important ideas relevant to the focus of the lesson	0.264	2	0.876
Intellectual rigor, constructive criticism, and the challenging of ideas were evident	0.192	2	0.909
The degree of “sense-making” of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson	1.777	2	0.411
Hours of LSC Professional Development	17.442	4	0.002
Use of LSC-Designated Instructional Materials	0.898	3	0.826

Appendix B

Descriptive Statistics for Analyses

Descriptive Statistics for Analysis: Capsule Rating (N = 1,610)

Table B-1a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.04	14.08
Transformed—Squared (in thousands)	0.40	10.00	6.00	2.05
Number of students in school				
Original	33.00	3,250.00	731.44	435.00
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.29	34.71
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.41	32.14
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-1b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

The mathematics/science content was significant and worthwhile (N = 1,600)

Table B-2a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.07	14.09
Transformed—Squared (in thousands)	0.40	10.00	5.99	2.05
Number of students in school				
Original	33.00	3,250.00	732.14	435.12
Transformed—Natural Log	3.50	8.09	6.45	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.37	34.72
Transformed—Arcsine of the Square Root	0.00	1.57	0.74	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.44	32.12
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-2b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	26
Urban	47
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of Students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

The mathematics/science content was appropriate for the developmental levels of the students in this class (N = 1,582)

Table B-3a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.03	14.13
Transformed—Squared (in thousands)	.40	10.00	5.98	2.06
Number of students in school				
Original	33.00	3,250.00	728.46	432.52
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.20	34.68
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.35	32.07
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-3b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

Active participation of all was encouraged and valued (N = 1,610)

Table B-4a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.04	14.08
Transformed—Squared (in thousands)	0.40	10.00	6.00	2.05
Number of students in school				
Original	33.00	3,250.00	731.44	435.00
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.29	34.71
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.41	32.14
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-4b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

There was a climate of respect for student's ideas, questions, and contributions (N = 1,597)

Table B-5a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.09	14.07
Transformed—Squared (in thousands)	0.40	10.00	5.99	2.05
Number of students in school				
Original	33.00	3,250.00	729.71	432.71
Transformed-Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.41	34.69
Transformed—Arcsine of the Square Root	0.00	1.57	0.74	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.41	32.13
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-5b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

Students were intellectually engaged with important ideas relevant to the focus of the lesson (N = 1,596)

Table B-6a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.11	14.07
Transformed—Squared (in thousands)	0.40	10.00	5.99	2.05
Number of students in school				
Original	33.00	3,250.00	730.70	433.98
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.29	34.70
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.31	32.08
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B6b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (N = 1,582)

Table B-7a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.09	14.08
Transformed—Squared (in thousands)	0.40	10.00	5.99	2.05
Number of students in school				
Original	33.00	3,250.00	730.17	431.09
Transformed—Natural Log	3.50	8.09	6.44	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.27	34.68
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.46	32.10
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed-Square Root	4.58	45.30	25.30	10.43

Table B-7b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	47
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification (N = 1,512)

Table B-8a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.03	14.04
Transformed—Squared (in thousands)	0.40	10.00	5.98	2.04
Number of students in school				
Original	33.00	3,250.00	734.79	441.83
Transformed—Natural Log	3.50	8.09	6.45	0.56
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.28	34.62
Transformed—Arcsine of the Square Root	0.00	1.57	0.73	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.18	32.15
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.41
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-8b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	18
11 or more years	52
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	27
Urban	46
Number of hours of LSC professional development	
0 hours	30
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	17
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

Intellectual rigor, constructive criticism, and the challenging of ideas were evident (N = 1,502)

Table B-9a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.01	14.05
Transformed—Squared (in thousands)	0.40	10.00	5.98	2.04
Number of students in school				
Original	33.00	3,250.00	736.21	438.33
Transformed—Natural Log	3.50	8.09	6.45	0.56
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.6	34.75
Transformed—Arcsine of the Square Root	0.00	1.57	0.74	0.45
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.66	32.11
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed—Square Root	4.58	45.30	25.30	10.43

Table B-9b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	15
Suburban	26
Urban	47
Number of hours of LSC professional development	
0 hours	31
1–19 hours	15
20–39 hours	12
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	15
Yes – medium adherence to the instructions in the teacher's manual	17
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	26
1–25 percent	55
26–50 percent	11
More than 50 percent	8

Descriptive Statistics for Analysis:

The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson (N = 1,501)

Table B-10a
Continuous Independent Variables

	Minimum	Maximum	Mean	Standard Deviation
Teacher's perception of principal support composite				
Original	20.00	100.00	76.13	14.02
Transformed—Squared (in thousands)	0.40	10.00	5.99	2.04
Number of students in school				
Original	33.00	3,250.00	735.21	438.83
Transformed—Natural Log	3.50	8.09	6.45	0.55
Proportion of students in school classified as non-Asian minority				
Original	0.00	100.00	45.49	34.53
Transformed—Arcsine of the Square Root	0.00	1.57	0.74	0.44
Proportion of students in school eligible for free/reduced-price lunch (FRL)				
Original	0.00	100.00	47.69	32.00
Transformed—Arcsine of the Square Root	0.00	1.57	0.76	0.40
Number of targeted teachers				
Original	21.00	2,052.00	747.63	565.30
Transformed-Square Root	4.58	45.30	25.30	10.43

Table B-10b
Categorical Independent Variables

	Percent of Lessons
Number of years of prior teaching experience	
0–5 years	30
6–10 years	19
11 or more years	51
Community type in which school is located	
Rural	11
Town or small city	16
Suburban	26
Urban	47
Number of hours of LSC professional development	
0 hours	31
1–19 hours	15
20–39 hours	11
40–79 hours	17
80 or more hours	26
Lesson based on LSC-designated instructional materials	
No	47
Yes – low adherence to the instructions in the teacher's manual	14
Yes – medium adherence to the instructions in the teacher's manual	16
Yes – high adherence to the instructions in the teacher's manual	22
Percent of students in school classified as limited-English proficient (LEP)	
0 percent	25
1–25 percent	56
26–50 percent	11
More than 50 percent	8

Appendix C

HLM Models:
Level 2 Specifications

HLM Models:

Capsule Rating

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
+ G_{11}*(Square Root of the Number of Targeted Teachers)
+ G_{12}*(K–8 Mathematics)
+ G_{13}*(6–12 Mathematics)
+ G_{14}*(6–12 Science)
+ U_1

$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

The mathematics/science content was significant and worthwhile

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
+ G_{11}*(Square Root of the Number of Targeted Teachers)
+ G_{12}*(K–8 Mathematics)
+ G_{13}*(6–12 Mathematics)
+ G_{14}*(6–12 Science)
+ U_1

$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

The mathematics/science content was appropriate for the developmental levels of the students in this class

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

Active participation of all was encouraged and valued

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

There was a climate of respect for student's ideas, questions, and contributions

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
+ G_{11}*(Square Root of the Number of Targeted Teachers)
+ G_{12}*(K–8 Mathematics)
+ G_{13}*(6–12 Mathematics)
+ G_{14}*(6–12 Science)
+ U_1

$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

Students were intellectually engaged with important ideas relevant to the focus of the lesson

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
+ G_{11}*(Square Root of the Number of Targeted Teachers)
+ G_{12}*(K–8 Mathematics)
+ G_{13}*(6–12 Mathematics)
+ G_{14}*(6–12 Science)
+ U_1

$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

Mathematics/science was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and/or proof/justification

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

Intellectual rigor, constructive criticism, and the challenging of ideas were evident

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
+ G_{01}*(Square Root of the Number of Targeted Teachers)
+ G_{02}*(K–8 Mathematics)
+ G_{03}*(6–12 Mathematics)
+ G_{04}*(6–12 Science)
+ U_0

$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$

HLM Models:

The degree of "sense-making" of mathematics/science content within this lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson

Level 2

The Level 2 model included a random error term and control variables as predictors of the Level 1 intercept. All other Level 1 coefficients were treated as fixed across projects.

$B_0 = G_{00}$
$+ G_{01}$*(Square Root of the Number of Targeted Teachers)
$+ G_{02}$*(K–8 Mathematics)
$+ G_{03}$*(6–12 Mathematics)
$+ G_{04}$*(6–12 Science)
$+ U_0$
$B_1 = G_{10}$
$B_2 = G_{20}$
$B_3 = G_{30}$
$B_4 = G_{40}$
$B_5 = G_{50}$
$B_6 = G_{60}$
$B_7 = G_{70}$
$B_8 = G_{80}$
$B_9 = G_{90}$
$B_{10} = G_{100}$
$B_{11} = G_{110}$
$B_{12} = G_{120}$
$B_{13} = G_{130}$
$B_{14} = G_{140}$
$B_{15} = G_{150}$
$B_{16} = G_{160}$