LSC Teacher Questionnaire Study: A Longitudinal Analysis of Data Collected Between 1997 and 2003

by

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Introduction

The LSC program was designed to provide all teachers of mathematics or science in a project's targeted schools with a substantial amount of professional development. Each project selected a set of standards-based instructional materials around which to build its professional development program. Because the projects were designed as systemic change initiatives, they also were intended to promote a supportive policy environment and to cultivate support from key stakeholders for standards-based classroom practice.

The professional development provided by LSC projects was variously intended to influence teachers' attitudes toward reform-oriented teaching, preparedness in content and pedagogy, and classroom practice. This study is intended to assess the influence of LSC professional development on these outcomes among teachers. For a variety of reasons the LSCs planned to provide professional development on different schedules for different groups of teachers, and were not entirely successful in providing the intended number of hours of professional development for all targeted teachers. As a result, the Core Evaluation data on teachers' professional development and outcomes among teachers include information from teachers with widely varying participation in professional development, including multiple data points for some teachers at different times. These data permitted the investigation of the relationships between teachers' extent of participation in LSC professional development and several outcomes of interest.

This study makes use of longitudinal questionnaire data collected from teachers that have been targeted by the LSC projects to date. A series of three-level hierarchical linear models (HLM), with time points nested in teachers nested in projects, was used to assess the impact of teacher participation in LSC professional development on teacher attitudes toward reform-based teaching, pedagogical preparedness, mathematics/science content preparedness, and use of both traditional and reform-based teaching practices.

Sample

Between 1997 and 2003, over 70,000 teachers submitted questionnaires. Because the vast majority of these cases had data at only two time points, an analysis of covariance approach was employed. The data set was further reduced by the removal of teacher leaders (who are not representative of the typical teacher targeted by the LSCs) and teachers with incomplete questionnaire data.[1] The final data set used in these analyses includes longitudinal data from more than 57,000 teachers, representing 85 LSC projects.[2]

[1] As a test, HRI imputed scores for missing data on items used to compute composites. The imputation was conducted with the SPSS MVA EM method. Composite scores were then recomputed. For selected analyses, models using the imputed data and the original data with missing cases were estimated and compared. The comparison of estimates from the HLM models indicated that the differences between the two datasets were quite small, and did not support imputing data for all analyses. The results that are reported, therefore, do not include imputed composite scores for cases with missing data.

[2] Eight projects had not yet collected teacher questionnaire data a second time.

The LSC core evaluation requires projects to collect questionnaire data from either a random sample of 300 teachers or their entire targeted population, if 350 or fewer teachers.[3] Because this sampling design leads to unequal probabilities of teachers being selected to receive a questionnaire, weights are used in these analyses. Table 1 shows the raw and weighted distribution of teachers in the sample by subject and grade range, as well as the number of projects targeting each subject/grade-range.

Table 1
Teachers and Projects Included in Model by Subject/Grade-Range

Subject/Grade-Range	Number of Projects	Number of Teachers	Percent of Teachers	Weighted Percent of Teachers
K–8 Science	42	19,781	49	57
K–8 Mathematics	29	13,669	34	33
6–12 Mathematics	19	5,717	14	9
6–12 Science	7	1,100	3	1
Total	**85**†	**40,267**‡	**100**	**100**

† The sum of projects is greater than the total as some projects target more than one subject/grade-range.
‡ The total number of teachers without missing data for any of the variables used in these analyses; it should be noted that each outcome variable had its own analysis with a different number of cases due to missing data and this number is the listwise deletion total for the dataset.

It is important to note that teacher participation in the LSC program and in the core evaluation is voluntary. Although teachers are randomly sampled to receive questionnaires and projects are required to attain an 80 percent response rate, the potential for non-response bias exists. An analysis of project-provided treatment level of teachers indicates that teachers that return a completed questionnaire tend to have slightly higher levels of participation in LSC professional development than teachers who do not return a questionnaire (see Table 2). Thus, the results of these analyses should be interpreted with some caution.

Table 2
Treatment Levels of Sampled Teachers, by Response

	Percent of Teachers	
	Yes	**No**
0 hours	29	33
1-19 hours	13	16
20-59 hours	19	21
60-99 hours	17	14
100-129 hours	10	9
130-159 hours	5	3
160-199 hours	3	2
200 or more hours	4	2

[3] Beginning with the 1999-2000 data collection year, projects also administered teacher questionnaires to a "program sample." The program sample was purposively selected to gather longitudinal data, with the size of each project's sample proportional to project size. The analyses presented in this report draw upon longitudinal data collected as part of the program sample and those collected serendipitously (teachers randomly selected at multiple time points).

Also, since teacher participation in LSC professional development is typically voluntary, the potential for self-selection bias exists. In an effort to determine whether teachers that participated fully in the LSC (i.e., teachers receiving at least 130 hours of professional development) were initially different than those that did not participate in the LSC (i.e., teachers that were targeted, but opted not to participate in LSC professional development), baseline data from the teacher questionnaire on 10 factors were compared:

- Attitudes toward reform-oriented teaching composite;
- Pedagogical preparedness composite;
- Content preparedness composite;
- Use of traditional teaching practices composite;
- Use of investigative teaching practices composite;
- Use of practices that foster an investigative classroom culture composite;
- Perceptions of principal support composite;
- Gender;
- Race (white vs. non-white); and
- Years of teaching experience.

Fully participating and non-participating teachers were statistically equivalent on 7 of the 10 factors, including perceptions of pedagogical and content preparedness, use of classroom practices, and perceptions of principal support. There was a significant difference on the attitudes toward reform-oriented teaching composite; fully participating teachers' initial score on this composite was slightly higher (i.e., more positive attitudes) than non-participants' score (an effect size of 0.25 standard deviations). Fully participating teachers, compared to non-participants, were also more likely to be white (87 percent vs. 80 percent) and female (84 percent vs. 78 percent), and were less likely to have over 20 years of teaching experience (25 percent vs. 33 percent). Thus, the generalizability of the findings from these analyses to the population of teachers targeted by the LSCs may be somewhat limited not only due to the fact that many teacher participated in LSC professional development as volunteers, but also because participants differed from non-participants on potentially important background characteristics.

Analysis and Results

The LSC teacher questionnaire data have a nested structure; with multiple time points nested within each teacher nested within each 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).

The six outcomes of interest in these analyses were teachers' composite scores[4] on:

- attitudes toward reform-based teaching;

[4] Each of these outcomes was measured by a factor-analytically derived composite score from items on the LSC Teacher Questionnaire. See "Technical Report: Analysis of the Psychometric Structure of the LSC Surveys" (12/07/98) by David B. Flora and A.T. Panter, L.L. Thurstone Psychometric Lab, University of North Carolina at Chapel Hill, NC for a detailed description of the factor analysis procedure.

- pedagogical preparedness;
- mathematics/science content preparedness;
- use of traditional teaching practices;
- use of investigative teaching practices; and
- use of teaching practices that foster an investigative culture.

Since the statistical approach employed assumes normal distributions, the distributions of the outcome variables were examined for normality, revealing concerns regarding the skewness and kurtosis of the distributions. Each was transformed using the transformation that yielded the best overall correction for skewness and kurtosis. Table 3 shows descriptive statistics for the original and transformed values of the six composite variables investigated as outcomes in these analyses, as well as the composite score for perceived principal support, which is used as an independent variable in the analyses.[5]

Table 3
Descriptive Statistics for Composite Variables

	Minimum	Maximum	Mean	Standard Deviation
Attitudes Toward Reform-Oriented Teaching				
Original	25.00	100.00	86.11	10.32
Transformed—Box and Cox	-24.90	0.00	-10.16	6.03
Pedagogical Preparedness				
Original	25.00	100.00	76.68	13.60
Transformed-Squared	6.25	100.00	60.63	20.22
Content Preparedness				
Original	25.00	100.00	66.12	18.18
Transformed—Box and Cox	-65.86	0.00	-31.72	16.24
Traditional Practices				
Original	20.00	100.00	63.27	20.01
Transformed—Box and Cox	-53.72	0.00	-29.80	13.50
Investigative Practices				
Original	20.00	100.00	52.49	14.34
Transformed—Square Root	44.72	100.00	71.74	9.93
Investigative Culture				
Original	20.00	100.00	79.50	13.78
Transformed—Box and Cox	-35.93	0.00	-15.66	8.43
Perceived Principal Support				
Original	20.00	100.00	75.69	14.41
Transformed—Squared	0.04	100.00	0.59	0.21

In general, teachers reported having fairly positive views toward reform-teaching practices. They also perceived themselves as having higher levels of pedagogical preparedness than science/mathematics content preparedness. In terms of classroom practices, teachers reported

[5] Unless otherwise noted, all statistics are based upon weighted data.

relatively high use of strategies that create a classroom culture for investigation into mathematics/science. Overall, they reported slightly more use of traditional practices than investigative practices.

For each outcome, a three-level hierarchical linear model (time points nested within teachers nested within projects) was used to investigate the relationship between teachers' composite scores, and the extent of their participation in LSC professional development. In addition, a number of teacher and school demographic factors were controlled in these models, for example, experience level of the teacher and the type of community in which their school was located.

The independent variables included at the time point level were:

- Project year;
- Extent of teacher's participation in LSC professional development;
- Teacher's experience level; and
- Teacher's perception of principal support.

The independent variables included at the teacher/school level were:

- Number of students enrolled in the teacher's school;
- Percent of students in the teacher's school classified as non-Asian minority;
- Percent of students in the teacher's school eligible for free/reduced-price lunch (FRL);
- Percent of students in the teacher's school classified as limited-English proficient (LEP); and
- Type of community in which the teacher's school is located.

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

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

Descriptive statistics for the time-point-level predictor variables are shown in Tables 4 and 5. The majority of questionnaires were submitted by teachers who had participated in fewer than 20 hours of LSC professional development at the time, but there was a wide range of extent of participation. Roughly half of the questionnaires in the sample came from teachers indicating that they had taught for 11 or more years, while about one-fourth indicated having 5 or fewer years of experience. On average, teachers indicated that their principals were supportive of their efforts, though there was a sizeable amount of variation in responses.

Over half of the questionnaires were from teachers located in schools in urban areas, about one-fourth in schools in suburban communities, with the remaining evenly divided between schools in rural areas and schools in towns/small cities. School sizes varied widely, ranging from 18 to over 3000 students. On average, the questionnaires came from teachers in schools with 47 percent of the students classified as non-Asian minority, 14 percent classified as limited-English proficient (LEP), and 50 percent eligible for free/reduced-price lunch.

Table 4
Descriptive Statistics for Time-Point-Level Variables

	Percent of questionnaires (N=57,297)
Extent of Teacher Participation in LSC Professional Development	
0 hours	35
1-19 hours	20
20-39 hours	13
40-59 hours	10
60-79 hours	6
80-99 hours	5
100-129 hours	6
130 or more hours	6
Prior Teaching Experience	
0-2 years	17
3-5 years	15
6-10 years	16
11-20 years	24
21 or more years	28
Project Year	
0	13
1	18
2	29
3	14
4	11
5	12
6	3

Table 5
Descriptive Statistics for Teacher/School-Level Variables

	Minimum	Maximum	Mean	Standard Deviation
Number of students in school				
Original	7	3,250	677	363
Transformed—Box and Cox	2.45	23.58	14.67	2.29
Percent of student body classified as Non-Asian minority				
Original (in hundreds)	0.00	1.00	0.47	0.35
Transformed—Folded Natural Log	0.69	1.39	1.09	0.14
Percent of students in school eligible for free/reduced-price lunch (FRL)				
Original (in hundreds)	0.00	1.00	0.50	0.31
Transformed—Box and Cox	-1.11	0.00	-0.53	0.34
Percent of students in school classified as limited-English proficient (LEP)				
Original (in hundreds)	0.00	1.00	0.14	0.21
Transformed—Box and Cox	-3.85	0.00	-2.26	1.13

At the project level, the analyses controlled for the subject/grade range targeted by the project and the size of the project (see Tables 6 and 7).

Table 6
Descriptive Statistics for Teacher/School-Level Categorical Variables

	Percent of Teachers
Community Type	
Rural	11
Town or Small City	15
Suburban	25
Urban	49

Table 7
Descriptive Statistics for Project-Level Variables

	Minimum	Maximum	Mean	Standard Deviation
Number of Targeted Teachers				
Original	21	2,052	739	560
Transformed—Square Root	4.58	45.30	25.14	10.40

HLM 5.05[6] 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). In all cases, the project-level random effects were significant for all time-point-level predictors and for the teacher/school-level predictors of the mean outcome. For each composite, two main models were run. The first included all control variables and project year as a predictor. (See Appendix A.) This model was developed to assess change in the outcome variable across all teachers over time.

The second model added the teacher's hours of professional development, and the teacher's perception of principal support. (See Appendix B.) This model was designed to assess the contribution of participation in LSC professional development with project year controlled. Preliminary investigation of the data suggested testing of linear, quadratic, and cubic relationships between professional development hours and the outcomes. In all models, these three trends were tested, retained in instances in which they were significant, and dropped when they were not. The teacher's perception of principal support was also included at this step because many of the LSC's conducted work with principals as a part of their initiatives, so controlling for this variable permitted a more direct focus on the relationship between professional development and the outcomes.

For these two models, the fixed-effects estimates of main effects on the outcome for each composite are shown in Table 8.

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

Table 8
Fixed Effects, by Composite and Model

	Attitudes Toward Reform-Oriented Teaching		Pedagogical Preparedness	
	Project Year Model	**Project Year, Professional Development, and Perception of Principal Support Model**	**Project Year Model**	**Project Year, Professional Development, and Perception of Principal Support Model**
Intercept	-10.08***	-9.89***	57.49***	59.18***
	(0.11)	(0.10)	(0.51)	(0.38)
Project Year	-0.09**	-0.19***	1.66***	0.87***
	(0.03)	(0.03)	(0.17)	(0.11)
Professional Development				
Linear		0.71***		8.39***
		(0.09)		(1.35)
Quadratic				-4.60*
				(1.83)
Cubic				1.33*
				(0.66)
Teacher's Perception of Principal Support		6.37***		28.73***
		(0.18)		(0.76)
Teacher Characteristics				
Experience Level (Intermediate Omitted)				
Novice (1–5 yr)	0.32**	0.36***	-2.27***	-1.84***
	(0.10)	(0.09)	(0.33)	(0.30)
Very Experienced (11+ yr)	-0.71***	-0.67***	1.06**	1.26***
	(0.10)	(0.09)	(0.34)	(0.28)
School Characteristics				
School Size	-0.17***	-0.12***	-0.21~	0.03
	(0.03)	(0.03)	(0.11)	(0.10)
Non-Asian Minority	4.35***	3.56***	3.34	4.23
	(0.91)	(0.92)	(3.01)	(2.79)
Limited-English Proficient	0.09	0.04	-0.16	-0.07
	(0.07)	(0.07)	(0.23)	(0.22)
Free or Reduced-Price Lunch	-0.28	0.13	-2.69**	-1.34
	(0.30)	(0.29)	(1.00)	(0.96)
Community Type (Urban Omitted)				
Rural	-0.13	-0.28	-1.48~	-1.46~
	(0.22)	(0.21)	(0.83)	(0.77)
Suburban	0.16	0.21	-0.08	0.21
	(0.17)	(0.16)	(0.54)	(0.53)
Town or Small City	-0.04	-0.05	-1.22~	-1.15~
	(0.17)	(0.17)	(0.70)	(0.62)
Project Characteristics				
Number of Targeted Teachers	-0.00	-0.00	-0.04	-0.02
	(0.01)	(0.01)	(0.06)	(0.04)
Project Subject/Grade Range (K-8 Science omitted)				
K-8 Math	0.68**	0.34	3.30**	1.41~
	(0.23)	(0.22)	(1.16)	(0.82)
6-12 Math	-1.61***	-1.72***	-2.36	-3.06**
	(0.33)	(0.31)	(1.63)	(1.17)
6-12 Science	-0.36***	-0.45	-0.41	-0.04
	(0.50)	(0.48)	(2.38)	(1.83)

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

Table 8 (continued)
Fixed Effects, by Composite and Model

	Content Preparedness		Traditional Practices	
	Project Year Model	**Project Year, Professional Development, and Perception of Principal Support Model**	**Project Year Model**	**Project Year, Professional Development, and Perception of Principal Support Model**
Intercept	-32.58*** (0.37)	-31.93*** (0.33)	-29.04*** (0.36)	-29.06*** (0.34)
Project Year	0.92*** (0.13)	0.61*** (0.10)	-0.04 (0.08)	-0.03 (0.08)
Professional Development				
Linear		2.17*** (0.23)		-0.13 (0.19)
Quadratic				
Cubic				
Teacher's Perception of Principal Support		13.08*** (0.56)		4.15*** (0.40)
Teacher Characteristics				
Experience Level (Intermediate Omitted)				
Novice (1–5 yr)	-0.91*** (0.23)	-0.73** (0.22)	0.18 (0.17)	0.18 (0.17)
Very Experienced (11+ yr)	0.22 (0.26)	0.27 (0.23)	0.35 (0.18)	0.33~ (0.17)
School Characteristics				
School Size	0.38*** (0.09)	0.49*** (0.09)	0.36*** (0.07)	0.41*** (0.07)
Non-Asian Minority	5.79** (2.03)	4.97* (2.00)	4.67** (1.67)	5.60** (1.69)
Limited-English Proficient	-0.62** (0.18)	-0.70*** (0.17)	-0.27~ (0.15)	-0.34 (0.15)
Free or Reduced-Price Lunch	-2.21** (0.71)	-1.07 (0.71)	-0.23 (0.64)	0.29 (0.65)
Community Type (Urban Omitted)				
Rural	-0.60 (0.55)	-0.95~ (0.55)	-0.31 (0.41)	-0.26 (0.44)
Suburban	0.75~ (0.44)	-0.65 (0.45)	-0.12 (0.33)	0.06 (0.35)
Town or Small City	-1.34** (0.45)	-1.23** (0.45)	-0.08 (0.35)	0.10 (0.37)
Project Characteristics				
Number of Targeted Teachers	-0.00 (0.04)	0.00 (0.04)	0.03 (0.04)	0.03 (0.04)
Project Subject/Grade Range (K-8 Science omitted)				
K-8 Math	9.45*** (0.79)	8.60*** (0.68)	13.19*** (0.78)	12.89*** (0.73)
6-12 Math	10.33*** (1.14)	10.11*** (0.99)	15.03*** (1.08)	14.90*** (1.02)
6-12 Science	15.21*** (1.68)	14.53*** (1.53)	11.62*** (1.59)	10.78*** (1.54)

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

Table 8 (continued)
Fixed Effects, by Composite and Model

	Investigative Practices		Investigative Culture	
	Project Year Model	**Project Year, Professional Development, and Perception of Principal Support Model**	**Project Year Model**	**Project Year, Professional Development, and Perception of Principal Support Model**
Intercept	71.06*** (0.26)	72.15*** (0.21)	-16.60*** (0.25)	-15.63*** (0.19)
Project Year	0.40*** (0.09)	-0.11~ (0.06)	0.49*** (0.08)	0.03 (0.06)
Professional Development				
Linear		10.37*** (0.78)		7.49*** (0.67)
Quadratic		-9.65*** (1.06)		-6.11*** (0.92)
Cubic		2.94*** (0.37)		1.73*** (0.33)
Teacher's Perception of Principal Support		8.90*** (0.31)		7.80*** (0.29)
Teacher Characteristics				
Experience Level (Intermediate Omitted)				
Novice (1–5 yr)	0.04 (0.15)	0.29~ (0.15)	0.02 (0.13)	0.20 (0.13)
Very Experienced (11+ yr)	-0.20 (0.14)	-0.16 (0.14)	-0.84*** (0.13)	-0.84*** (0.13)
School Characteristics				
School Size	-0.19** (0.06)	-0.14* (0.06)	-0.09* (0.04)	-0.01 (0.04)
Non-Asian Minority	4.35** (1.42)	3.65** (1.34)	1.84 (1.19)	1.17 (1.16)
Limited-English Proficient	0.37** (0.12)	0.44*** (0.12)	0.16 (0.10)	0.17~ (0.10)
Free or Reduced-Price Lunch	-0.56 (0.56)	0.23 (0.54)	-2.33*** (0.45)	-1.66*** (0.43)
Community Type (Urban Omitted)				
Rural	0.07 (0.44)	0.06 (0.41)	-0.57 (0.35)	-0.85** (0.32)
Suburban	-0.06 (0.31)	0.20 (0.30)	-0.17 (0.25)	-0.11 (0.19)
Town or Small City	-0.37 (0.39)	-0.26 (0.37)	-0.35 (0.32)	-0.41 (0.29)
Project Characteristics				
Number of Targeted Teachers	0.02 (0.03)	0.02 (0.02)	-0.01 (0.03)	-0.03~ (0.02)
Project Subject/Grade Range (K-8 Science omitted)				
K-8 Math	-0.54 (0.59)	-1.34** (0.45)	2.59 (0.55)	1.82*** (0.41)
6-12 Math	-3.13*** (0.82)	-4.09*** (0.64)	0.39 (0.77)	-0.37 (0.58)
6-12 Science	0.68 (1.22)	0.47 (1.00)	-1.02 (1.12)	-1.84* (0.88)

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

Relationships between Professional Development and Attitudes toward Reform-oriented Teaching

Key results from the analyses for the attitudes toward reform-oriented teaching outcome are summarized in Figures 1 and 2. Project year, without controlling for teachers' participation in professional development, was not significantly related to attitudes toward reform-oriented teaching, indicating no significant change on this variable across all teachers over time. (See Figure 1.) It should be noted that scores on this composite were relatively high, leaving little room for growth.

Teachers participating in more hours of LSC professional development scored higher on this composite than teachers who had participated in fewer hours, while controlling for project year and perception of principal support. Only the linear relationship between professional development hours and attitudes toward reform-oriented teaching was statistically significant. (See Figure 2.) For teachers with the mean amount of professional development (36 hours) the effect on attitudes toward reform-oriented teaching was 0.04 standard deviations, equivalent to a 0.4 point increase on this composite. For teachers with professional development hours one standard deviation above the mean (84 hours) the effect on this composite was 0.1 standard deviations, equivalent to 0.92 points. These effects for professional development are over and above the effects of project year and principal support because these factors are controlled in these models.

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and attitudes toward reform-oriented teaching was significant and negative, with a very small effect of -0.03 standard deviations, corresponding to a decrease of 0.29 points per year. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and attitudes toward reform-oriented teaching was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.22 standard deviations on attitudes toward reform-oriented teaching, or a 2.13 point increase.

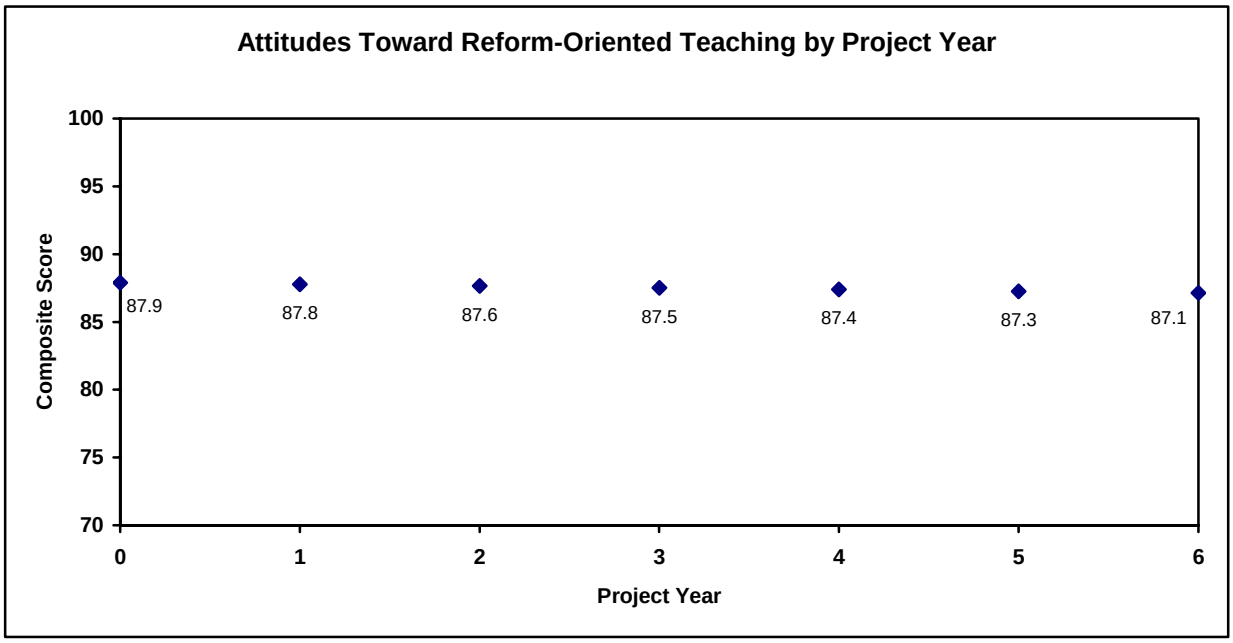

Figure 1

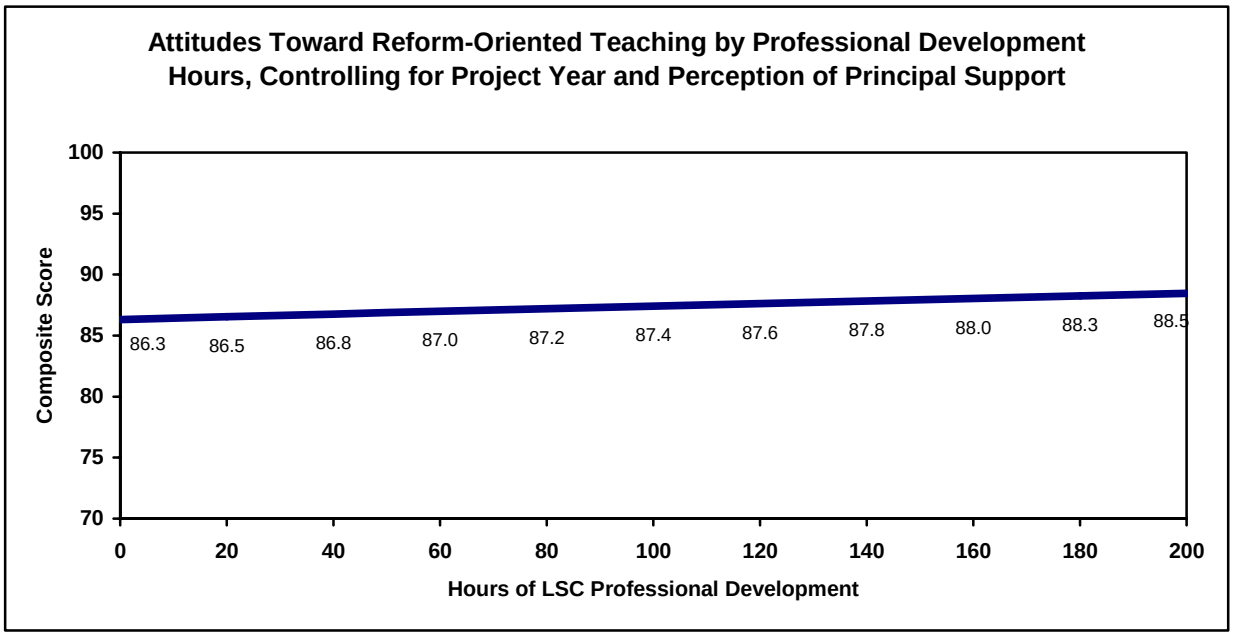

Figure 2

Relationships between Professional Development and Pedagogical Preparedness

Key results from the analyses for the pedagogical preparedness outcome are summarized in Figures 3 and 4. Project year, without controlling for teachers' participation in professional development, was significantly and positively related to pedagogical preparedness, indicating a significant increase on this variable across all teachers over time. (See Figure 3.) Each year of

an LSC project corresponded to an effect of 0.08 standard deviations on this composite, or a 1.09 point increase.

Teachers participating in more hours of LSC professional development scored higher on this composite than teachers who had participated in fewer hours. The linear, quadratic, and cubic trends for this relationship were all statistically significant. (See Figure 4.) The effect for the mean amount of professional development (36 hours) was 0.18 standard deviations, equivalent to a 2.34 point increase on this composite. At one standard deviation above the mean amount of professional development (84 hours) the effect was 0.34 standard deviations, equivalent to an increase of 4.27 points. These effects for professional development are over and above the effects of project year and principal support because these factors were controlled in the model.

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and pedagogical preparedness remained significant and positive, with a very small effect of 0.04 standard deviations, corresponding to an increase of 0.56 points per year. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and pedagogical preparedness was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.30 standard deviations on pedagogical preparedness, or a 3.88 point increase.

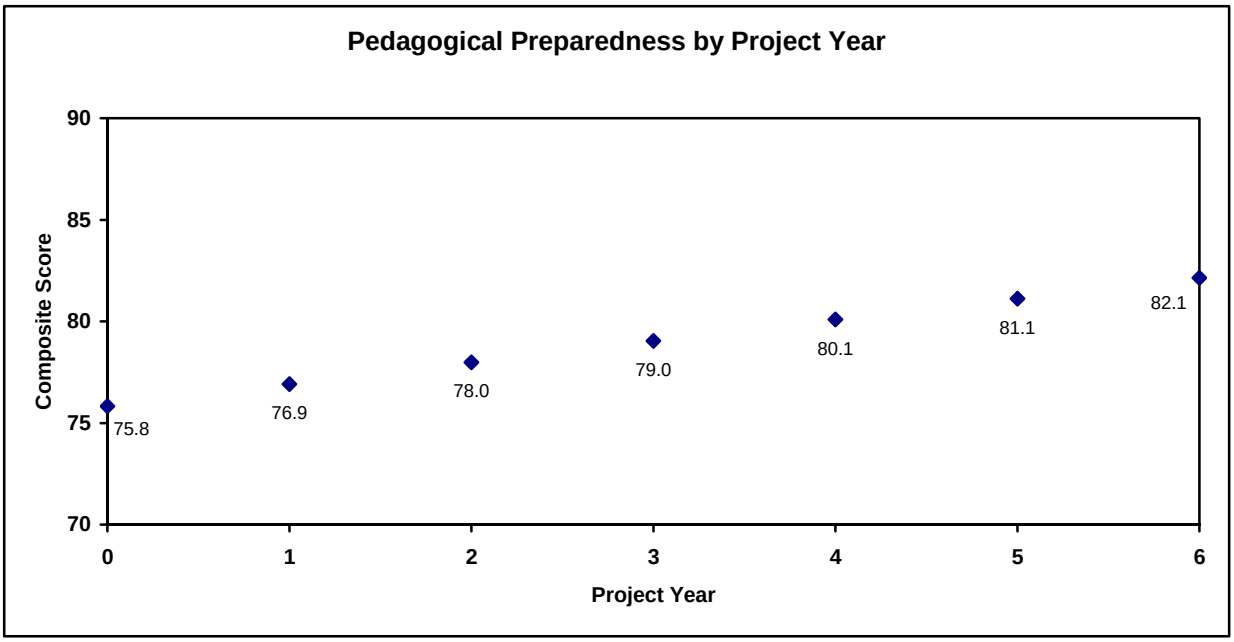

Figure 3

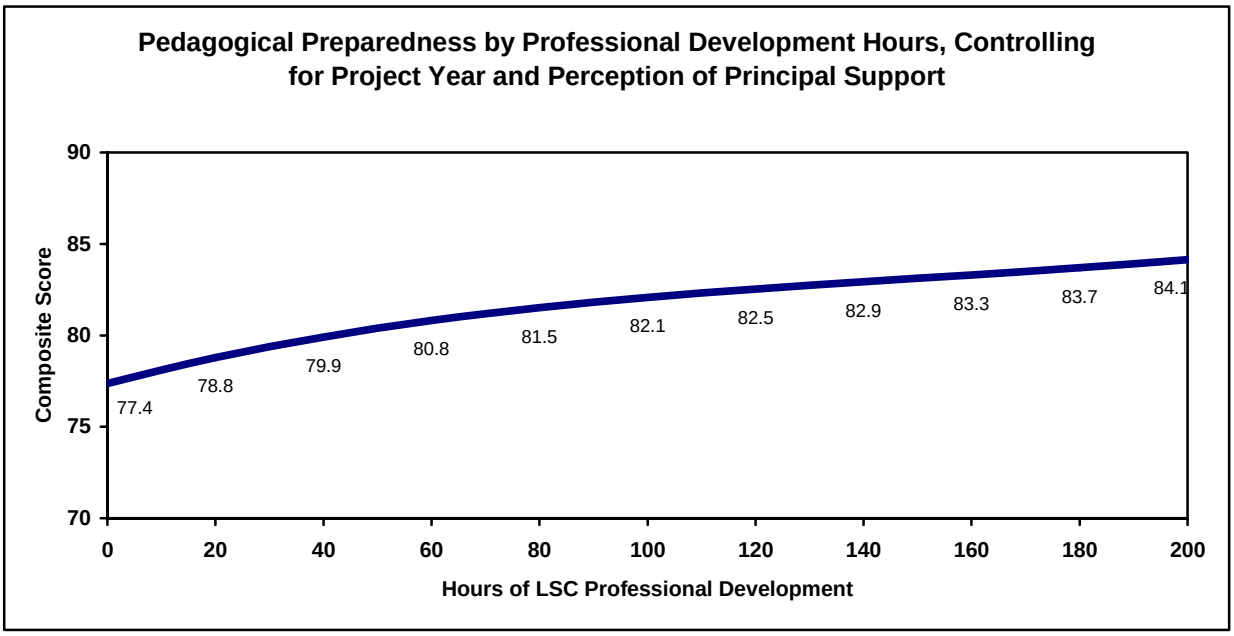

Figure 4

Relationships between Professional Development and Content Preparedness

Key results from the analyses for the content preparedness outcome are summarized in Figures 5 and 6. Project year, without controlling for teachers' participation in professional development, was significantly and positively related to content preparedness, indicating a significant increase on this variable across all teachers over time. (See Figure 5.) Each year of an LSC project corresponded to an effect of 0.06 standard deviations on this composite, or a 1.06 point increase.

Teachers participating in more hours of LSC professional development scored higher on this composite than teachers who had participated in fewer hours. Only the linear trend for this relationship was statistically significant. (See Figure 6.) The effect for the mean amount of professional development (36 hours) was 0.05 standard deviations, equivalent to a 0.86 point increase on this composite. At one standard deviation above the mean amount of professional development (84 hours) the effect was 0.11 standard deviations, equivalent to an increase of 1.99 points. These effects for professional development are over and above the effects of project year and principal support because these factors were controlled in the model.

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and content preparedness remained significant and positive, with a very small effect of 0.04, corresponding to an increase of 0.68 points per year. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and content preparedness was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.17 on content preparedness, or a 3.02 point increase.

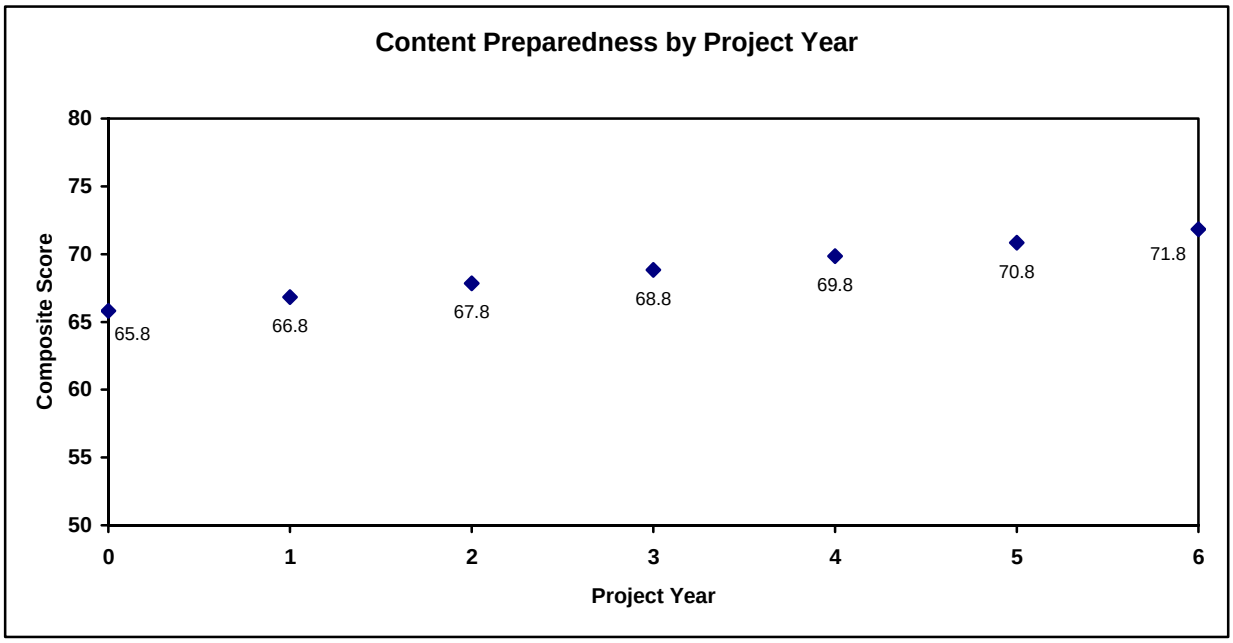

Figure 5

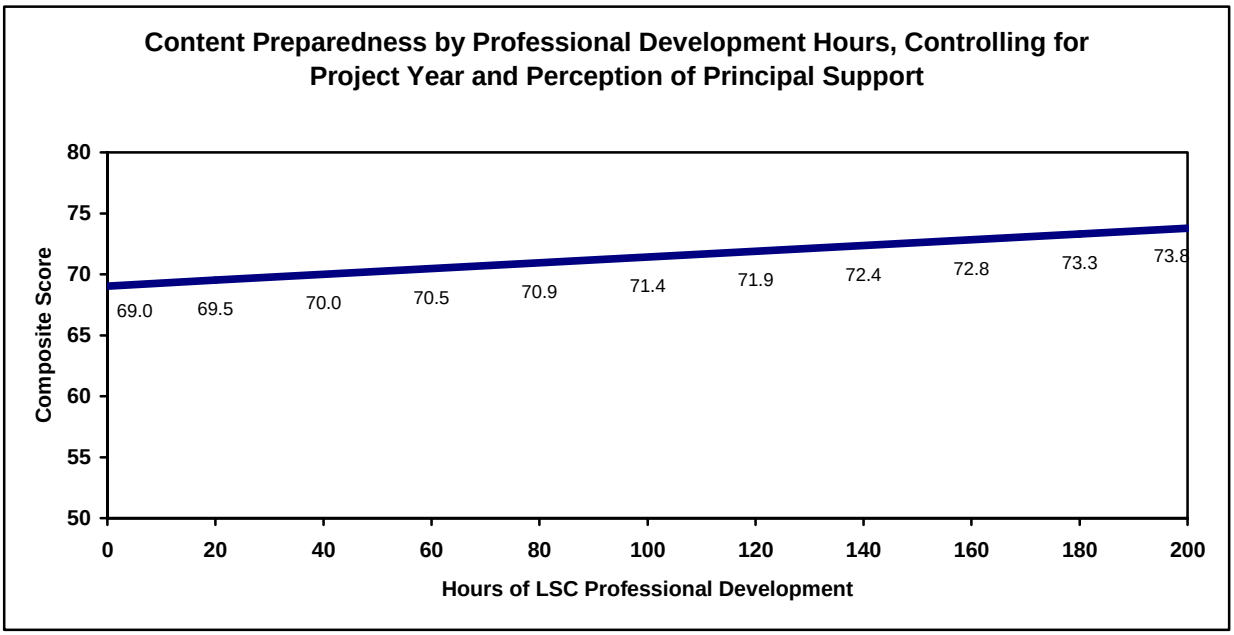

Figure 6

Relationships between Professional Development and Traditional Practices

Key results from the analyses for the traditional teaching practices outcome are summarized in Figures 7 and 8. Project year, without controlling for teachers' participation in professional development, was not significantly related to traditional teaching practices, indicating no significant change on this variable across all teachers over time. (See Figure 7.)

Extent of teachers' LSC professional development was not significantly related to the traditional practices outcome, while controlling for project year and perception of principal support. (See Figure 8.)

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and traditional teaching practices remained non-significant. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and traditional teaching practices was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.06 standard deviations on traditional teaching practices, or a 1.19 point increase.

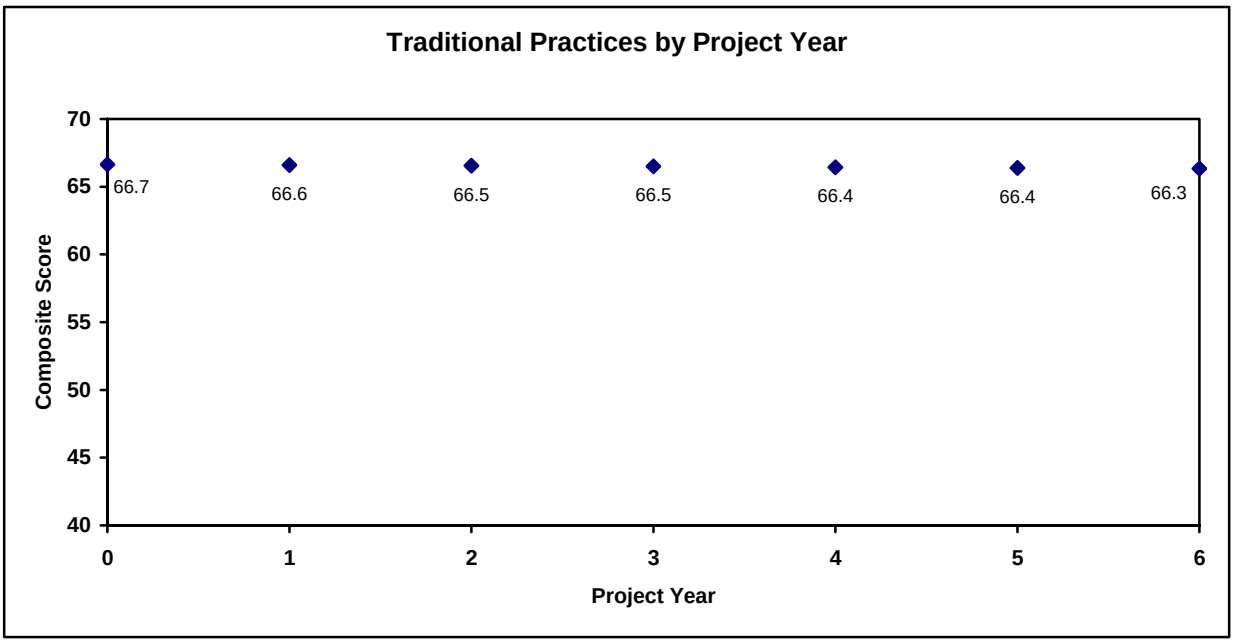

Figure 7

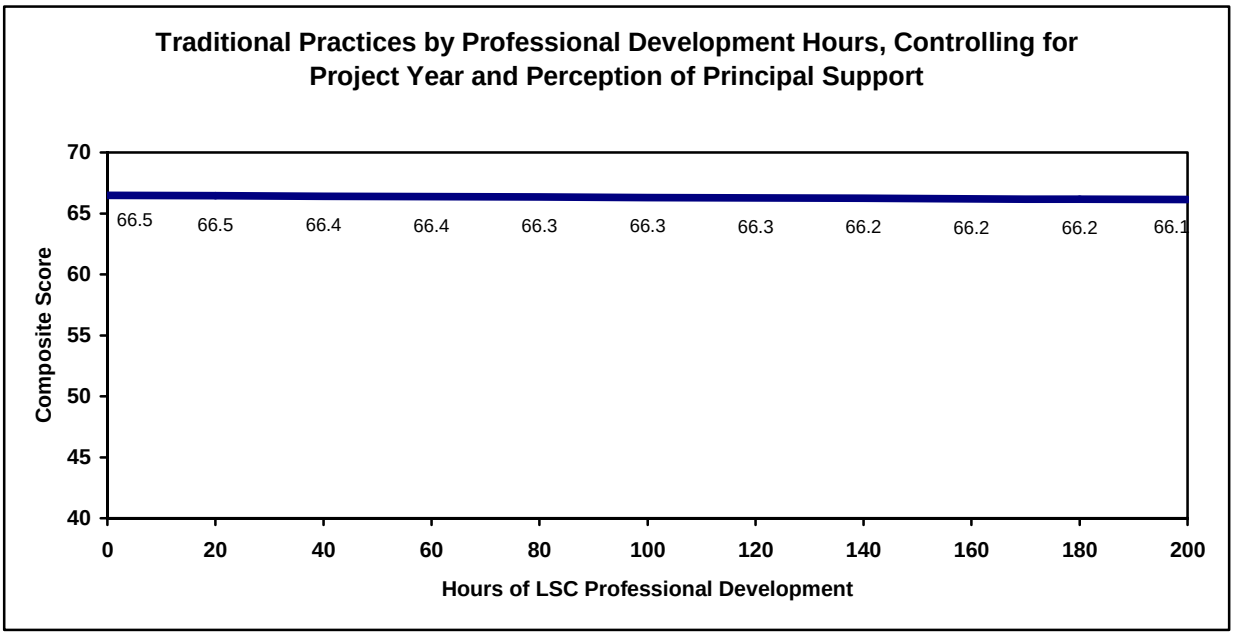

Figure 8

Relationships between Professional Development and Investigative Practices

Key results from the analyses for the pedagogical preparedness outcome are summarized in Figures 9 and 10. Project year, without controlling for teachers' participation in professional development, was significantly and positively related to investigative classroom culture, indicating a significant increase on this variable across all teachers over time. (See Figure 9.) Each year of an LSC project corresponded to an effect of 0.04 standard deviations on this composite, or a 0.57 point increase.

Teachers participating in more hours of LSC professional development scored higher on this composite than teachers who had participated in fewer hours. The linear, quadratic, and cubic trends for this relationship were all statistically significant. (See Figure 10.) The effect for the mean amount of professional development (36 hours) was 0.53 standard deviations, equivalent to a 7.35 point increase on this composite. At one standard deviation above the mean amount of professional development (84 hours) the effect was 0.83 standard deviations, equivalent to an increase of 11.74 points. These effects for professional development are over and above the effects of project year and principal support because these factors were controlled in the model.

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and investigative classroom practices was no longer significant, suggesting that changes on these two control variables accounted for the increase in this outcome over time. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and investigative classroom practices was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.19 standard deviations on investigative classroom practices, or a 2.64 point increase.

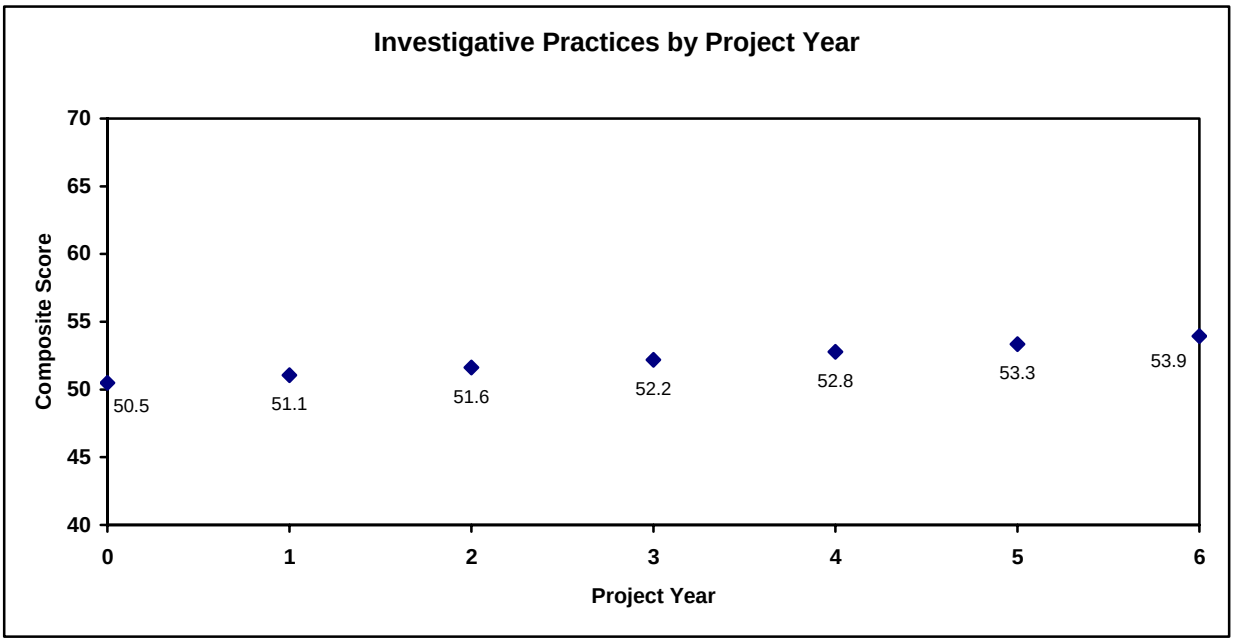

Figure 9

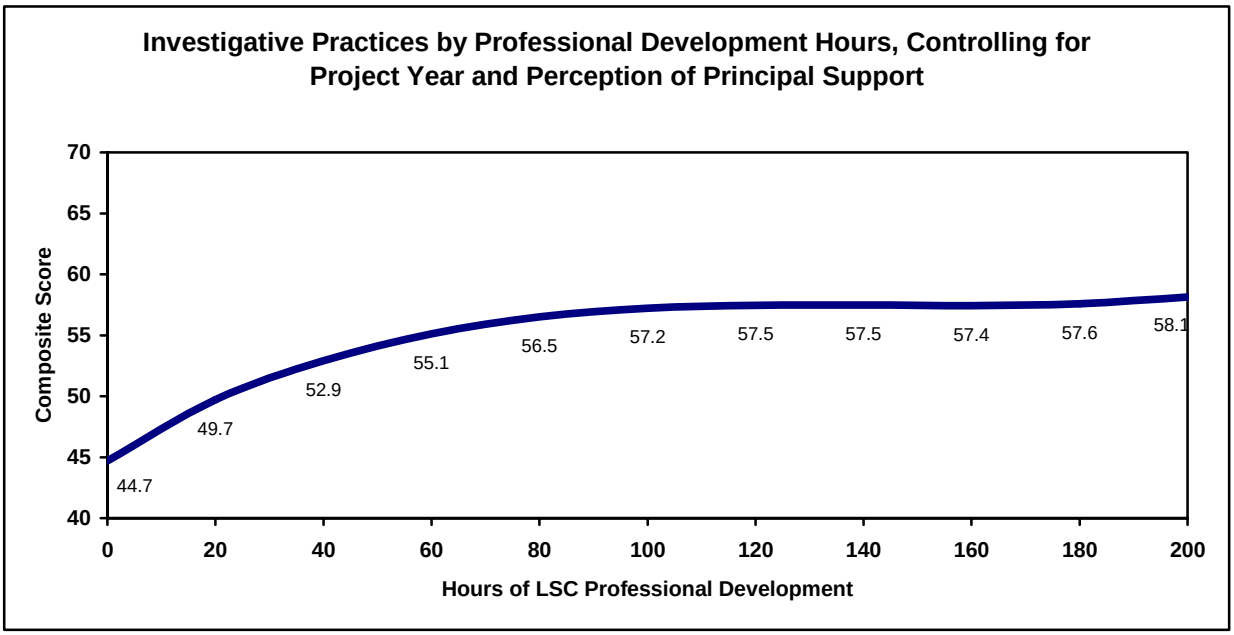

Figure 10

Relationships between Professional Development and Investigative Culture

Key results from the analyses for the pedagogical preparedness outcome are summarized in Figures 11 and 12. Project year, without controlling for teachers' participation in professional development, was significantly and positively related to investigative classroom culture, indicating a significant increase on this variable across all teachers over time. (See Figure 11.)

Each year of an LSC project corresponded to an effect of 0.06 standard deviations on this composite, or a 1.10 point increase.

Teachers participating in more hours of LSC professional development scored higher on this composite than teachers who had participated in fewer hours. The linear, quadratic, and cubic trends for this relationship were all statistically significant. (See Figure 12.) The effect for the mean amount of professional development (36 hours) was 0.38 standard deviations and equivalent to a 7.69 point increase on this composite. At one standard deviation above the mean amount of professional development (84 hours), the effect was 0.65 standard deviations, equivalent to an increase of 12.09 points. These effects for professional development are over and above the effects of project year and principal support because these factors were controlled in the model.

With hours of LSC professional development and perceptions of principal support controlled, the relationship between project year and investigative classroom culture was no longer significant, suggesting that changes on these two control variables accounted for the increase in this outcome over time. Controlling for LSC professional development and project year, the relationship between perceptions of principal support and investigative classroom culture was significant and positive. A one standard deviation increase in perceptions of principal support had an effect of 0.19 standard deviations on investigative classroom culture, or a 3.62 point increase.

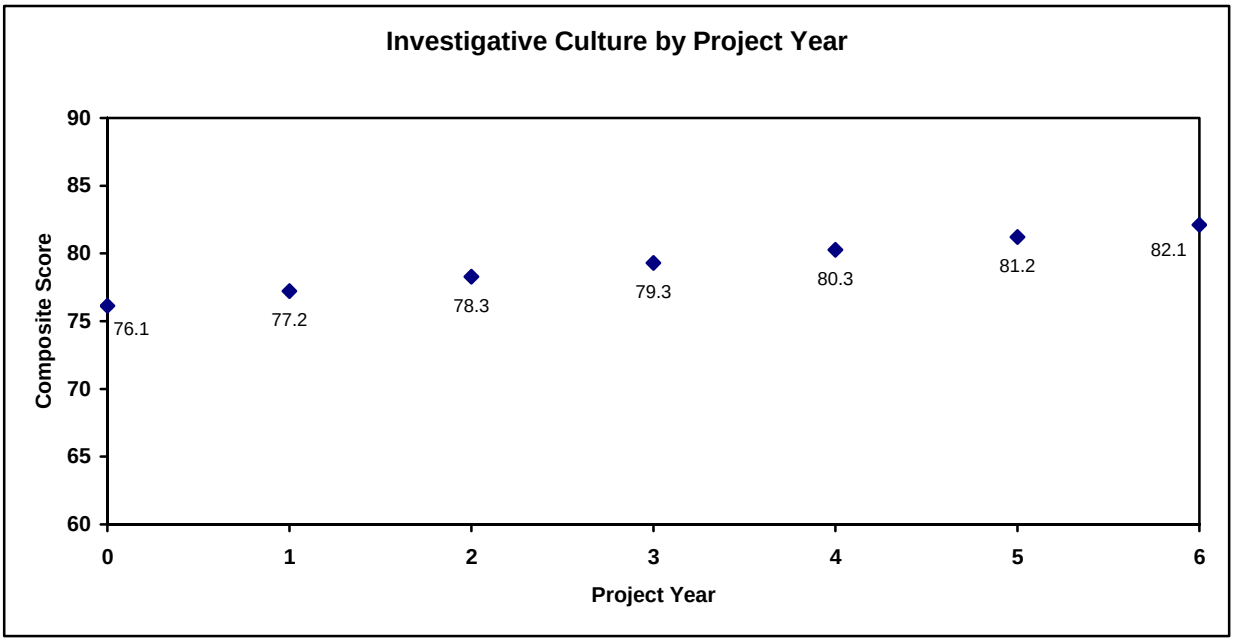

Figure 11

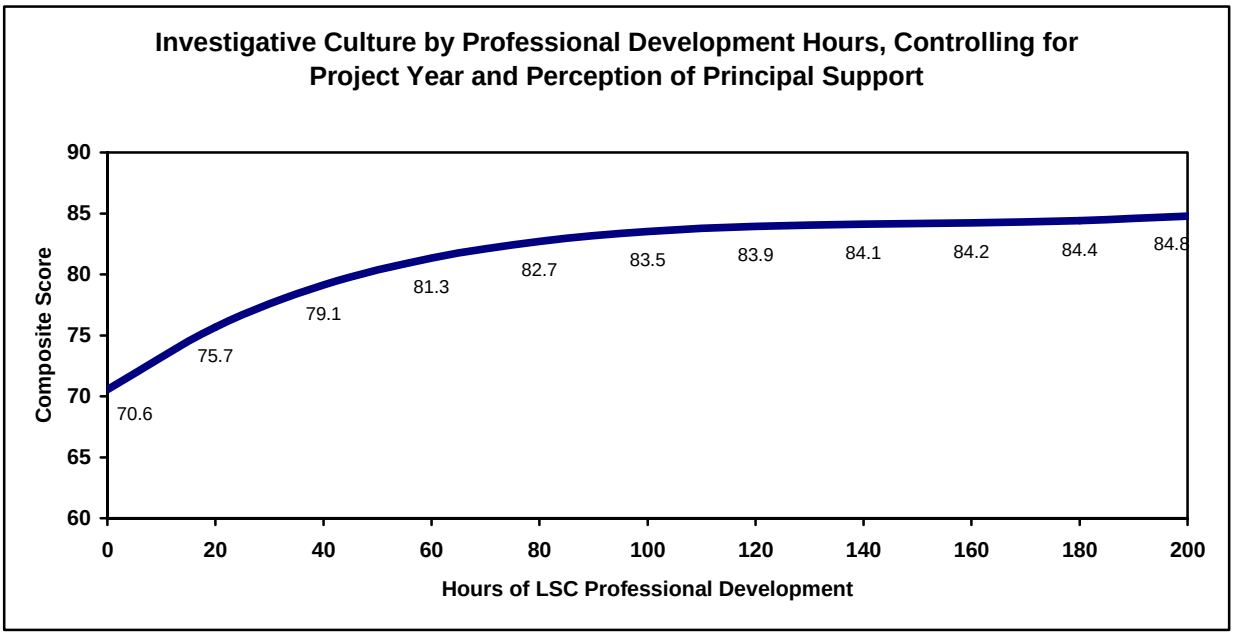

Figure 12

Conclusions

Looking across the different models, three main findings are evident. First, there was an overall increase across all teachers over time on pedagogical preparedness, mathematics/science content preparedness, and use of reform-oriented teaching strategies. For investigative classroom practices and investigative classroom culture the overall increase over time was explained by differences in teachers' extent of participation in LSC professional development and perceptions of principal support. For pedagogical preparedness and content preparedness, by contract, the increase over time was not fully explained by these two variables. This result could suggest an overall increase on these factors, unrelated to the LSC. It could also represent that the preparedness variables are increasing over time as a result of a more systemic impact of the LSC on teachers, regardless of their direct involvement in LSC professional development or perceptions of principal support.

Second, there was a positive relationship between teachers' extent of participation in LSC professional development and growth in their pedagogical preparedness, mathematics/science content preparedness, and use of reform-oriented teaching practices. This finding supports the central premise of the LSC that extensive and targeted professional development will have an impact on teachers' attitudes, preparedness, and practice. The modest size of these impacts, and the trend for several of these impacts to stabilize at higher levels of professional development, may be explained by unmeasured contextual factors that limit potential impacts on teachers, or by a ceiling effect on the measurement of these outcomes. It may be, however, that the LSC program has fairly limited overall effects on teachers.

Third, even after taking initial differences and extent of participation in LSC professional development into account, teachers' perception of principal support was related to higher scores on these outcomes in the LSC projects. Although this relationship was fairly weak, it suggests

that school principals play a key role in teachers' attitudes, feelings of preparedness, and classroom practice. A number of the LSCs have included activities designed specifically to strengthen principal support for the project and for teachers participating in the project. Although it cannot be determined from these analyses whether teachers' perceptions of principal support are related to those activities, the results do suggest that working with principals to develop support for teacher change is likely an important reform strategy.

Finally, it is worth noting that some relationships were detected between targeted outcomes among teachers and factors such as teacher experience and the project's targeted subject/grade range. These findings suggest that projects should take these factors into account when planning, implementing, and evaluating their professional development and other interventions. Depending on teachers' backgrounds and the subject and grade range targeted by the project, participating teachers may be at somewhat different starting points. Expectations for the trajectory and extent of change among teachers may also depend on these factors. These findings do not, however, suggest that LSC professional development has been more or less effective depending on these factors.

It is important to note that all measures of teacher attitudes, preparedness, and practice are based upon self-report data. It is also important to note that even though the LSC was intended to target all teachers in a jurisdiction, in practice teacher participation in the professional development tends to be voluntary, so there is a danger of selection bias in the sample (i.e., teachers who decide to participate may be the better teachers). However, the longitudinal nature of these analyses minimizes this threat as much as possible without the use of random assignment. Regardless of these limitations, the results of this study are encouraging and appear to indicate that the LSC program is having the intended impacts on participating teachers and their practice.

Appendix A
Project Year Model

Level 1

The level 1 model for the prediction of the final composite score (Y) is:

Y = P0 + P1*(NOVTCHR) + P2*(EXPTCHR) + P3*(PROJYR) + E

Level 2

Level 2 control variables were included as predictors of the level 1 intercept term and the slope term for project year:

P0 = B00 + B01*(NUMST_T) + B02*(NOASN_T) + B03*(FRL_T) + B04*(LEP_T)
+ B05*(RURAL) + B06*(TOWN) + B07*(SUBURB) + R0
P1 = B10
P2 = B20
P3 = B30 + B31*(NUMST_T) + B32*(NOASN_T) + B33*(FRL_T) + B34*(LEP_T)
+ B35*(RURAL) + B36*(TOWN) + B37*(SUBURB)

Level 3

Level 3 control variables were included as predictors of the level 2 intercept term and the slope for project year:

B00 = G000 + G001(SQRTTARG) + G002(ELEMMATH) + G003(SECMATH) + G004(SECSCI) + U00
B01 = G010 + U01
B02 = G020 + U02
B03 = G030 + U03
B04 = G040 + U04
B05 = G050 + U05
B06 = G060 + U06
B07 = G070 + U07
B10 = G100 + U10
B20 = G200 + U20
B30 = G300 + G301(SQRTTARG) + G302(ELEMMATH) + G303(SECMATH) + G304(SECSCI) + U30
B31 = G310
B32 = G320
B33 = G330
B34 = G340
B35 = G350
B36 = G360
B37 = G370

Appendix B
Project Year, Professional Development (Linear Trend) and Teacher's Perception of Principal Support Model

Level 1

The level 1 model for the prediction of the final composite score (Y) is:

$$Y = P0 + P1*(NOVTCHR) + P2*(EXPTCHR) + P3*(PROJYR) + P4*(PDMIDPT) + P5*(CON9) + E$$

Level 2

Level 2 control variables were included as predictors of the level 1 intercept term, and the slope terms for project year, professional development, and perception of principal support:

$$P0 = B00 + B01*(NUMST\_T) + B02*(NOASN\_T) + B03*(FRL\_T) + B04*(LEP\_T) + B05*(RURAL) + B06*(TOWN) + B07*(SUBURB) + R0$$
$$P1 = B10$$
$$P2 = B20$$
$$P3 = B30 + B31*(NUMST\_T) + B32*(NOASN\_T) + B33*(FRL\_T) + B34*(LEP\_T) + B35*(RURAL) + B36*(TOWN) + B37*(SUBURB)$$
$$P4 = B40 + B41*(NUMST\_T) + B42*(NOASN\_T) + B43*(FRL\_T) + B44*(LEP\_T) + B45*(RURAL) + B46*(TOWN) + B47*(SUBURB)$$
$$P5 = B50 + B51*(NUMST\_T) + B52*(NOASN\_T) + B53*(FRL\_T) + B54*(LEP\_T) + B55*(RURAL) + B56*(TOWN) + B57*(SUBURB)$$

Level 3

Level 3 control variables were included as predictors of the level 2 intercept term, and the slope terms for project year, professional development, and perceptions of principal support:

$$B00 = G000 + G001(SQRTTARG) + G002(ELEMMATH) + G003(SECMATH) + G004(SECSCI) + U00$$
$$B01 = G010 + U01$$
$$B02 = G020 + U02$$
$$B03 = G030 + U03$$
$$B04 = G040 + U04$$
$$B05 = G050 + U05$$
$$B06 = G060 + U06$$
$$B07 = G070 + U07$$
$$B10 = G100 + U10$$
$$B20 = G200 + U20$$
$$B30 = G300 + G301(SQRTTARG) + G302(ELEMMATH) + G303(SECMATH) + G304(SECSCI) + U30$$
$$B31 = G310$$
$$B32 = G320$$
$$B33 = G330$$
$$B34 = G340$$
$$B35 = G350$$
$$B36 = G360$$
$$B37 = G370$$
$$B40 = G400 + G401(SQRTTARG) + G402(ELEMMATH) + G403(SECMATH) + G404(SECSCI) + U40$$
$$B41 = G410$$
$$B42 = G420$$
$$B43 = G430$$
$$B44 = G440$$
$$B45 = G450$$

B46 = G460
B47 = G470
B50 = G500 + G501(SQRTTARG) + G502(ELEMMATH) + G503(SECMATH) + G504(SECSCI) + U50
B51 = G510
B52 = G520
B53 = G530
B54 = G540
B55 = G550
B56 = G560
B57 = G570

Appendix C
Project Year, Professional Development (Linear, Quadratic, and Cubic Trends) and Teacher's Perceptions of Principal Support Model

Level 1

The level 1 model for the prediction of the final composite score (Y) is:

Y = P0 + P1*(NOVTCHR) + P2*(EXPTCHR) + P3*(PROJYR) + P4*(PDMIDPT) + P5*(CON9) + P6*(PDSQR) + P7*(PDCUB) + E

Level 2

Level 2 control variables were included as predictors of the level 1 intercept term, and the slope terms project year, professional development, and perception of principal support:

P0 = B00 + B01*(NUMST_T) + B02*(NOASN_T) + B03*(FRL_T) + B04*(LEP_T)
+ B05*(RURAL) + B06*(TOWN) + B07*(SUBURB) + R0
P1 = B10
P2 = B20
P3 = B30 + B31*(NUMST_T) + B32*(NOASN_T) + B33*(FRL_T) + B34*(LEP_T)
+ B35*(RURAL) + B36*(TOWN) + B37*(SUBURB)
P4 = B40 + B41*(NUMST_T) + B42*(NOASN_T) + B43*(FRL_T) + B44*(LEP_T)
+ B45*(RURAL) + B46*(TOWN) + B47*(SUBURB)
P5 = B50 + B51*(NUMST_T) + B52*(NOASN_T) + B53*(FRL_T) + B54*(LEP_T)
+ B55*(RURAL) + B56*(TOWN) + B57*(SUBURB)
P6 = B60 + B61*(NUMST_T) + B62*(NOASN_T) + B63*(FRL_T) + B64*(LEP_T)
+ B65*(RURAL) + B66*(TOWN) + B67*(SUBURB)
P7 = B70 + B71*(NUMST_T) + B72*(NOASN_T) + B73*(FRL_T) + B74*(LEP_T)
+ B75*(RURAL) + B76*(TOWN) + B77*(SUBURB)

Level 3

Level 3 control variables were included as predictors of the level 2 intercept term, and the slopes for project year, professional development, and perception of principal support slope:

B00 = G000 + G001(SQRTTARG) + G002(ELEMMATH) + G003(SECMATH) + G004(SECSCI) + U00
B01 = G010 + U01
B02 = G020 + U02
B03 = G030 + U03
B04 = G040 + U04
B05 = G050 + U05
B06 = G060 + U06
B07 = G070 + U07
B10 = G100 + U10
B20 = G200 + U20
B30 = G300 + G301(SQRTTARG) + G302(ELEMMATH) + G303(SECMATH) + G304(SECSCI) + U30
B31 = G310
B32 = G320
B33 = G330
B34 = G340
B35 = G350
B36 = G360
B37 = G370
B40 = G400 + G401(SQRTTARG) + G402(ELEMMATH) + G403(SECMATH) + G404(SECSCI) + U40
B41 = G410
B42 = G420

B43 = G430
B44 = G440
B45 = G450
B46 = G460
B47 = G470
B50 = G500 + G501(SQRTTARG) + G502(ELEMMATH) + G503(SECMATH) + G504(SECSCI) + U50
B51 = G510
B52 = G520
B53 = G530
B54 = G540
B55 = G550
B56 = G560
B57 = G570
B60 = G600 + G601(SQRTTARG) + G602(ELEMMATH) + G603(SECMATH) + G604(SECSCI) + U60
B61 = G610
B62 = G620
B63 = G630
B64 = G640
B65 = G650
B66 = G660
B67 = G670
B70 = G700 + G701(SQRTTARG) + G702(ELEMMATH) + G703(SECMATH) + G704(SECSCI) + U70
B71 = G710
B72 = G720
B73 = G730
B74 = G740
B75 = G750
B76 = G760
B77 = G770