Local Systemic Change through Teacher Enhancement

Year Nine Cross-Site Report

By

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Acknowledgments

The core evaluation of the Local Systemic Change Initiative requires the energy, efforts, and insights of a very large number of people.

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I. Introduction to the Local Systemic Change Initiative

In the spring and summer of 1995, the National Science Foundation (NSF) funded the first cohort of eight projects in a new initiative, the Local Systemic Change through Teacher Enhancement (LSC) program. Eighteen additional projects were funded in 1996, 20 in 1997, 12 in 1998, 13 in 1999, 9 in 2000, 7 in 2001, and 1 in 2002 for a total of 88 projects in Cohorts 1–8. No new LSC projects were funded in 2003.

The goal of the LSC program is to improve the teaching of science, mathematics, and technology by focusing on the professional development of teachers within whole schools or school districts. Each targeted teacher is to participate in a minimum of 130 hours of professional development over the course of the project.[1] In addition to its focus on involving all teachers in a jurisdiction, the LSC initiative is distinguished from previous teacher enhancement efforts by its emphasis on preparing teachers to implement designated exemplary mathematics and science instructional materials in their classrooms.

LSC projects are expected to align policy and practice within the targeted district(s) and to include:

- A shared comprehensive vision of science, mathematics, and technology education;
- Active partnerships and commitments among stakeholders;
- A detailed self-study that provides a realistic assessment of the system's strengths and needs;
- Strategic planning that incorporates mechanisms for engaging each teacher in intensive professional development activities over the course of the project; and
- A set of clearly defined, measurable outcomes for teaching, and an evaluation plan that provides ongoing feedback to the project.

The LSC solicitation indicated NSF's plan to "provide a framework for data collection (including a set of instruments and procedures) that will allow the Foundation to evaluate individual projects, aggregate data and information across projects, and produce a cross-project analysis" (NSF 94-73). NSF contracted with Horizon Research, Inc. (HRI) of Chapel Hill, NC to design the data collection framework, provide technical assistance in its implementation, and prepare an annual cross-site analysis of the evaluation results.

This section provides an overview of the LSC projects and a description of core evaluation data collection activities. Subsequent sections present the findings from the core evaluation activities conducted from September 1, 2002 through August 31, 2003.

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

A. An Overview of LSC Projects in Cohorts 1–8

Data provided by the PIs and questionnaires completed by the principals of targeted schools provide some basic information about the LSC projects included in Cohorts 1–8.

- The LSC initiative has funded 38 K–8 science projects, 6 secondary science projects, 18 K–8 mathematics projects, 14 secondary mathematics projects, 6 projects that targeted both elementary mathematics and science, 1 project that targeted both elementary and secondary science, and 5 projects that targeted both elementary and secondary mathematics.

- Thirty-eight of the LSC projects were single-district projects; at the other end of the scale, 4 projects involved more than 20 districts each.

- Sixty-six of the projects were funded as five-year projects, 14 as four-year, and 8 as three-year; although a number of projects have been granted no-cost extensions.

- The 88 current and completed projects plan to involve a total of approximately 70,000 teachers in roughly 4,000 schools in 467 districts across the United States.

- By the completion of these projects, an estimated 2,142,000 students will receive instruction from LSC-treated teachers each year.

During the 2002-03 data collection year, 39 LSCs were still active (see Table 1).[2] Most projects targeted a single subject (e.g., K–8 mathematics); five projects targeted multiple subjects (i.e., K–12 Mathematics, K–12 Science, K–8 Mathematics/Science).

Table 1
Active LSCs, by Targeted Subject[†]

	Number of Projects
Mathematics	
K–8	10
6–12	6
K–12	2
Science	
K–8	12
6–12	6
K–12	1
K–8 Mathematics/Science	**2**

[†] Three LSC projects targeted middle school only; one is categorized as 6–12 mathematics, two are categorized as 6–12 science.

[2] Three projects completed data collection in 1998, 6 in 1999, 8 in 2000, 19 in 2001, and 13 in 2002; these 49 projects are not included in the analyses in this report.

B. Schools Participating in 2002–03

As can be seen in Figure 1, 39 percent of the schools targeted for the LSC are in urban areas, 25 percent are in suburban areas, 19 percent are in rural areas, and 17 percent are in towns or small cities.

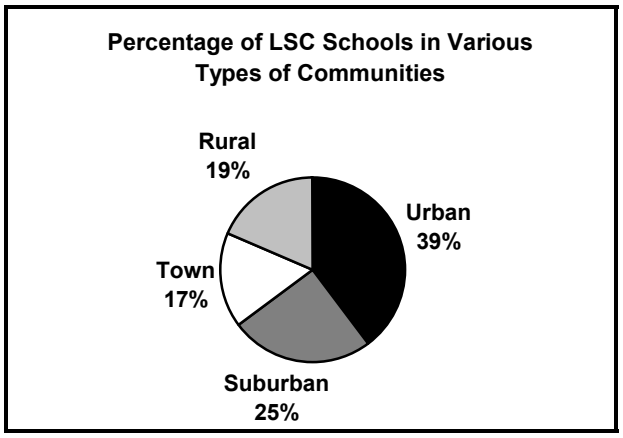

Figure 1

In terms of student demographics, across all schools targeted by the LSCs, 52 percent of students are white, 20 percent Hispanic, 18 percent African-American, 8 percent Asian, 1 percent American Indian or Alaskan Native, 0.1 percent Native Hawaiian or Pacific Islander, and 0.4 percent are from another background. As can be seen in Figure 2, projects targeting K–8 mathematics serve the largest proportion of minority students, but in each subject the representation of minority students is about as large as, if not larger than, the national average of approximately 40 percent.

The typical school targeted for K–8 mathematics or science reform by the LSC projects has 474 students, 50 percent of whom qualify for free or reduced-price lunches and 12 percent of whom are of limited English proficiency (LEP). The typical school targeted for 6–12 mathematics or science reform has 761 students, 33 percent of whom are eligible for free or reduced-price lunches and 6 percent of whom are classified as LEP.

C. Description of Core Evaluation Data Collection and Analysis

HRI worked with the National Science Foundation and PIs and evaluators of the LSC projects on the design and implementation of a core evaluation system to allow aggregating information across projects. This section describes the data collection activities associated with the core evaluation. Subsequent sections of the report present results for the four core evaluation questions listed below, followed by a summary section.

LSC Core Evaluation Questions

- What is the overall quality of the LSC professional development activities?
- What is the extent of school and teacher involvement in LSC activities?
- What is the impact of the LSC professional development on teacher preparedness, attitudes, and beliefs about mathematics and science teaching and learning?
- What is the impact of the LSC professional development on classroom practices in mathematics and science?

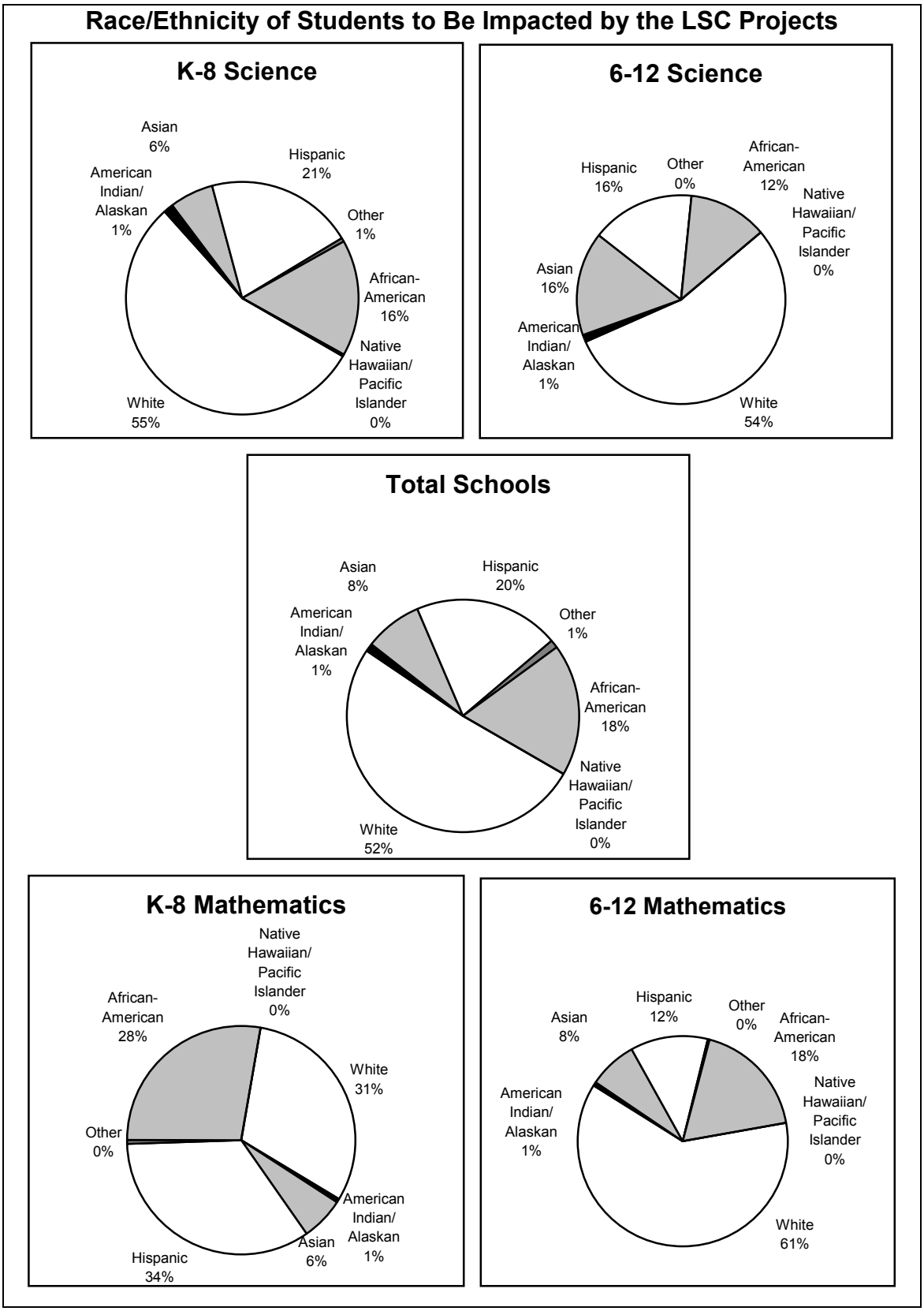
Race/Ethnicity of Students to Be Impacted by the LSC Projects
K-8 Science
Asian 6%
Hispanic 21%
American Indian/ Alaskan 1%
Other 1%
African-American 16%
Native Hawaiian/ Pacific Islander 0%
White 55%
6-12 Science
Hispanic 16%
Other 0%
African-American 12%
Native Hawaiian/ Pacific Islander 0%
Asian 16%
American Indian/ Alaskan 1%
White 54%
Total Schools
Asian 8%
Hispanic 20%
American Indian/ Alaskan 1%
Other 1%
African-American 18%
Native Hawaiian/ Pacific Islander 0%
White 52%
K-8 Mathematics
Native Hawaiian/ Pacific Islander 0%
African-American 28%
White 31%
Other 0%
American Indian/ Alaskan 1%
Asian 6%
Hispanic 34%
6-12 Mathematics
Hispanic 12%
Other 0%
Asian 8%
African-American 18%
American Indian/ Alaskan 1%
Native Hawaiian/ Pacific Islander 0%
White 61%

Figure 2

Data Collection
Data collection activities for the projects' 2002–03 Core Evaluation Reports were conducted from September 1, 2002 through August 31, 2003. The single Cohort 8 project was collecting data at the end of their first full year of funding; at the other end of the spectrum, this was the seventh year of data collection for Cohort 3 projects. There were no active Cohort 1 or 2 projects in 2002–03. The Core Evaluation Data Collection schedule was adjusted in 1999–2000 with the goal of transitioning to a longitudinal system. As a result, some projects conducted less-extensive evaluation activities than in previous years, resulting in an overall smaller pool of data for some analyses.

Data collection activities included the following:

1. ***Observations of Professional Development Activities***
   The core evaluation calls for projects to conduct 5–8 observations of professional development sessions and record their observations on standardized protocols. Evaluators were to consult with PIs on what professional development experiences were planned throughout the data collection year, and to select a sample that was representative of the diversity of the project's activities. Program-wide, a total of 233 observations of professional development sessions were conducted. Data were weighted to control for the variable number of observations conducted per project.

2. ***Classroom Observations***
   Twenty-four of the 39 active projects were scheduled to conduct classroom observations of randomly selected teachers (or their backups) in the spring of 2003, with the number of observations ranging from 12 to 16 per project. There was a total of 382 classrooms observed, roughly three-fourths of which were taught by teachers who had participated in at least 20 hours of LSC professional development. In all cases, the data were weighted to represent the total population of eligible teachers in the project.

3. ***Teacher Questionnaires***
   Twenty-six projects administered teacher questionnaires developed for the core evaluation to a random sample of teachers for each targeted subject; the median response rate among projects was 85 percent. A total of 6,383 teacher questionnaires were returned to HRI, including 1,537 from K–8 science teachers, 487 from 6–12 science teachers, 3,099 from K–8 mathematics teachers, and 1,260 from 6–12 mathematics teachers. Weights were added to the data file to reflect the probability of each teacher's selection into the sample, adjusted for any non-response in that project.

4. ***Principal Questionnaires***
   All projects were asked to administer questionnaires to the entire population of principals of targeted schools. Return rates on the principal questionnaire were generally higher than for the teacher questionnaire; a total of 1,468 principal questionnaires were returned, with a median response rate among projects of 98 percent.

5. Teacher Interviews

Evaluators were asked to interview a random sample of 10 teachers who had participated in at least 20 hours of professional development activities in that project. A total of 414 interviews were conducted among 39 projects. Seventy-six percent of the interviews were conducted by phone, and 24 percent were conducted in person. Evaluators reported the interview data by completing an interview summary form with both ratings and direct quotations from the participating teachers. Interview data from each project were weighted to reflect the total number of teachers who had participated in LSC professional development in that project.

Table 2 provides a summary of the number of projects participating in each data collection activity, by targeted subject.[3] The number of projects collecting data for each core evaluation component mirrors the requirements of the core evaluation system. All projects are required to administer principal questionnaires, conduct professional development observations, and interview teachers each year; teacher questionnaires and classroom observations are required only during the Baseline Year, Year Two, and Final Year of the project.

Table 2
Projects Participating in Each Core Evaluation Component, by Targeted Subject

	Number of Projects			
	Science		Mathematics	
	K–8	6–12	K–8	6–12
Professional Development Observations	15	6	14	7
Classroom Observations	8	4	11	8
Teacher Questionnaires	6	5	11	8
Principal Questionnaires	15	7	14	8
Teacher Interviews	15	7	14	8

Data Analysis

To facilitate the reporting of large amounts of survey data, and because individual questionnaire items are potentially unreliable, HRI used factor analysis to identify survey questions that could be combined into "composites."[4] Each composite represents an important construct related to one of the core evaluation questions. For example, there is a composite on the quality of LSC professional development, and several on teacher attitudes, preparedness, and classroom practice.[5]

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[3] In projects targeting both mathematics and science, or both elementary and secondary mathematics, questionnaire, observation, and interview data were collected separately for each "subject." Thus, the sum of projects is greater than the total number of active projects.

[4] 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.

[5] See http://www.horizon-research.com/LSC/news/composites/composites.pdf for definitions of the composite variables.

Once the questionnaire items associated with each composite were identified, composite scores were created. The composites are calculated as percentages of total points possible. An individual teacher's composite score is calculated by summing his/her responses to the items associated with that composite and then dividing by the total points possible. For example, if a composite is based on six survey questions asked on a five-point scale of "strongly disagree" to "strongly agree," that composite has 30 total possible points. If a teacher's raw composite score on these six items adds to 24 points, the percentage score is 80 (computed as $24 \div 30 \times 100$). A project's mean composite score is computed by averaging the scores of the individual teachers in that project.

In the results presented in this report, teachers, schools, and projects are sometimes categorized by targeted subject (K–8 science, 6–12 science, K–8 mathematics, or 6–12 mathematics). Analyses of the impact of the LSC initiative on teachers and their teaching are typically reported by extent of teacher involvement in LSC professional development activities.[6] Differences in proportions were tested using Chi-square procedures. Analysis of variance and t-tests were used to test the significance of differences in means of continuous variables, using the Bonferroni adjustment to compensate for the fact that multiple comparisons were performed. Differences noted in this report are statistically significant at the 0.05 level.

[6] "Teacher leaders" are likely not representative of the typical teacher targeted by the LSCs and were omitted from these analyses.

II. Quality of LSC Professional Development

A. Introduction

For the core evaluation, project evaluators were asked to observe 5–8 professional development activities in each ongoing project. Evaluators and PIs were to decide jointly which activities would be observed, selecting sessions to represent the diversity of the project's professional development offerings and to reflect the extensiveness and importance of the various kinds of activities. A total of 233 professional development sessions was observed.

This section of the report presents a summary of data collected from observations of individual sessions across all LSC projects, including descriptive information about the observed sessions and evaluators' assessments of their quality. The section concludes with teacher and evaluator judgments of the overall quality of the LSC professional development programs.[7]

B. Description of LSC Professional Development Sessions

Evaluators documented a number of features of each professional development session, providing information about targeted participants, presenters/facilitators, purposes and content focus, and the major types of activities that characterized the sessions.

Participants
The majority of professional development sessions observed for the LSC core evaluation included between 11 and 50 participants. Of sessions targeting teachers, 10 percent exclusively targeted teacher leaders, 82 percent targeted only regular teachers, and 7 percent targeted both lead and regular teachers. A total of 7 percent of the sessions included principals or other administrators.

Presenters/Facilitators
LSC professional development involves presenters/facilitators from a variety of settings. Sixty-seven percent of the observed sessions included one or more district personnel as presenters or facilitators, while only 23 percent of the sessions included university faculty as presenters or facilitators. (See Figure 3.) Across all of the observed sessions, 70 percent of the presenters/facilitators were female and 30 percent were male. As can be seen in Figure 4, 88 percent of the presenters/facilitators were white and 12 percent were members of other race/ethnic groups.

[7] In addition to the core evaluation data collection, evaluators observed all or parts of additional professional development activities without completing core evaluation protocols, and interviewed teachers about their professional development experiences, using project-specific protocols. All of the available data were to be used in making the summary judgments.

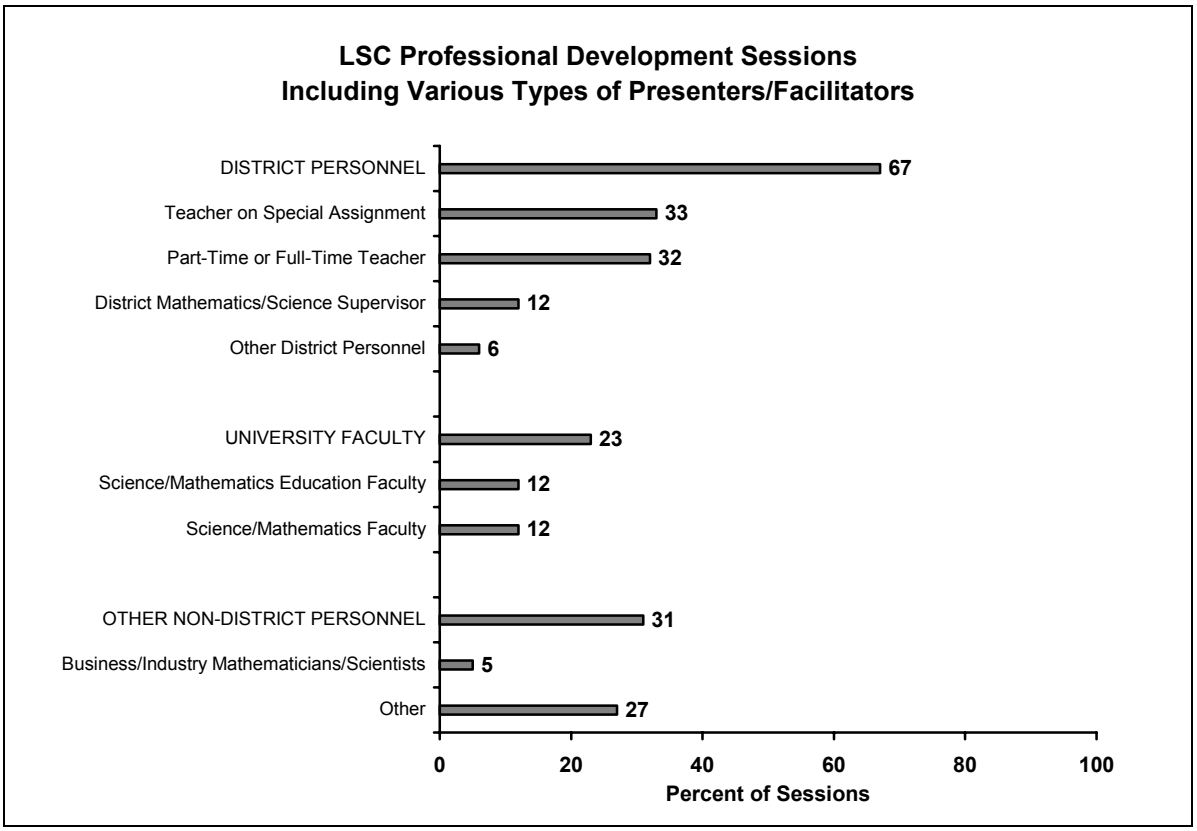

Figure 3

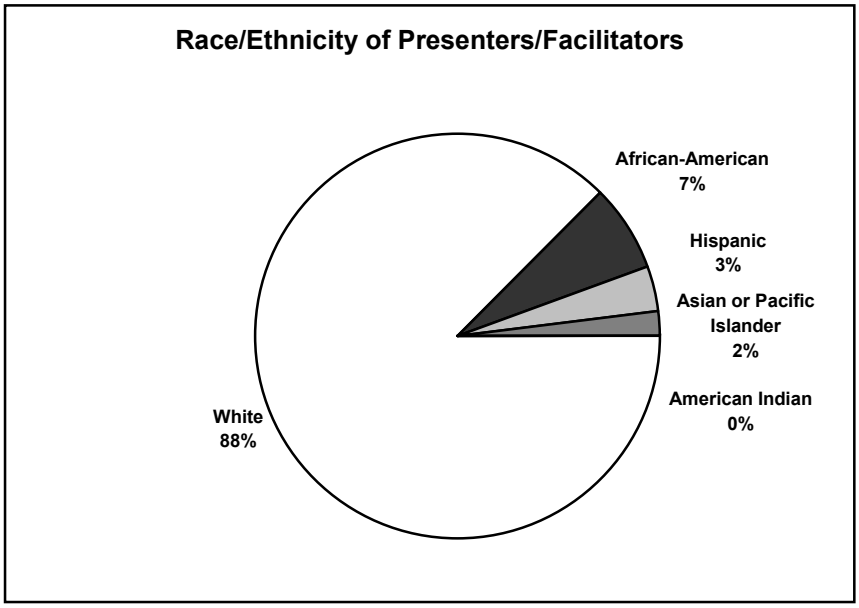

Figure 4

Purposes of the Professional Development Sessions

Evaluators were asked to indicate the primary intended purposes of each observed session based on information provided by the session facilitators. The vast majority of the observed sessions dealt with classroom practice, either pedagogy or the implementation of designated instructional materials. As can be seen in Table 3, 77 percent of the sessions included attention to issues of classroom pedagogy or use of the designated instructional materials, and 39 percent of the sessions included a focus on teacher content knowledge.

Table 3
Primary Intended Purposes of LSC Professional Development Sessions

	Percent of Sessions				
	All Sessions	Science		Mathematics	
		K–8	6–12	K–8	6–12
Explicit attention to classroom pedagogy/designated instructional materials	**77**	**68**	**82**	**77**	**89**
Learning how to use specific instructional materials in the classroom	41	35	39	41	52
Understanding student thinking/learning about mathematics/science content	36	25	43	34	55
Learning pedagogical/classroom management strategies	32	30	41	31	31
Creating a vision of effective mathematics/science instruction	32	24	42	40	26
Considering issues of scope and sequence (e.g., K-12 curricular frameworks)	15	9	32	14	14
Designing or scoring student assessments	11	11	13	13	9
Considering issues of access, equity, and diversity	7	1	11	8	15
Learning how to use technology in the classroom	5	1	17	3	4
Increasing mathematics/science content knowledge of participants	**39**	**39**	**42**	**28**	**54**
Explicit attention to strategies/issues/roles of teacher leaders, principals, or others in leadership positions	**10**	**14**	**3**	**11**	**4**
Other major purposes	**33**	**16**	**63**	**37**	**30**
Promoting/exploring reflective practice	20	10	27	27	21
Building professional networks among educators	11	0	34	15	4
Orientation to the project	6	4	11	8	0
Developing the capacity of participants to use technology	3	2	12	0	2
Assessing participants' knowledge/skills	2	1	6	3	0
Involving administrators and/or other school/district personnel in the reform process	2	1	3	2	0

Content Focus of Professional Development Sessions

When sessions focused on one or more disciplinary content areas, evaluators were asked to categorize that content. In K–8 science projects, evaluators reported that slightly more than half of the sessions with a disciplinary content focus dealt with physical science concepts (52 percent); fewer addressed concepts from life science (34 percent), earth and space sciences (28 percent), or "science as a way of knowing" (8 percent). Six percent or fewer of the observed K–8 science sessions dealt with measurement, engineering and design principles, patterns and relationships or data collection and analysis. (See Figure 5.)

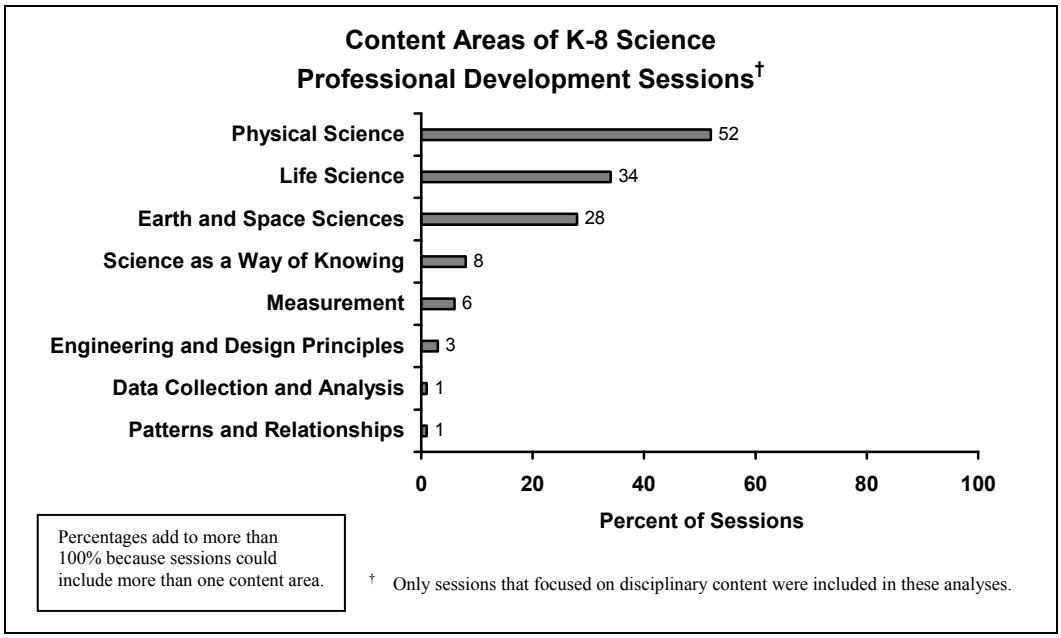

Figure 5

Projects targeting grade 6–12 science most heavily emphasized science as a way of knowing (42 percent), as can be seen in Figure 6. Other topics that frequently received emphasis were physical science (37 percent), life science (34 percent), and earth and space sciences (25 percent).

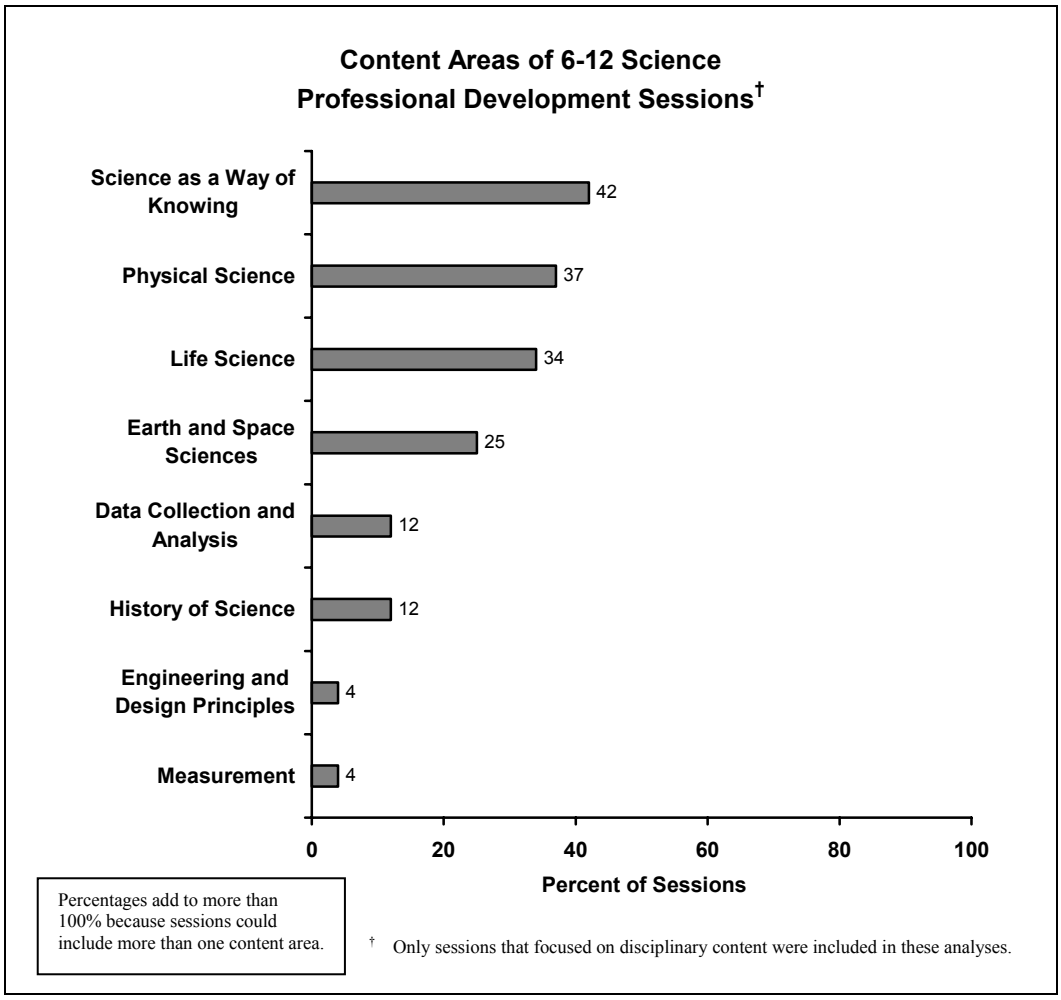

Figure 6

In projects targeting K–8 mathematics (Figure 7), the most heavily emphasized topics were numeration and number theory (34 percent of the sessions that dealt with disciplinary content), geometry and spatial sense (26 percent), and computation (25 percent). Fewer than 20 percent of the disciplinary content sessions focused on data collection and analysis, estimation, patterns and relationships, measurement, or mathematics as a way of knowing, and fewer than 10 percent addressed concepts in algebra, pre-algebra, or probability.

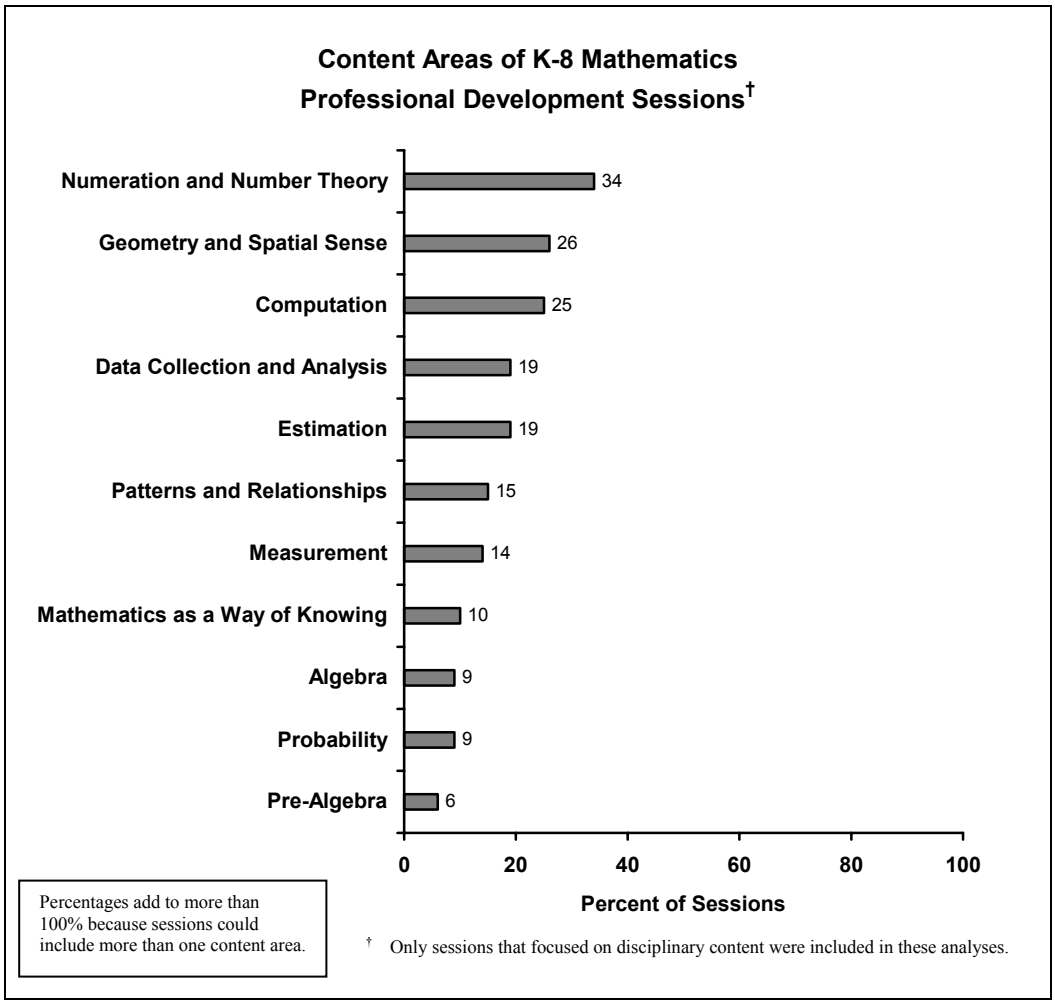

Figure 7

As can be seen in Figure 8, 31 percent of the disciplinary content-focused sessions for 6–12 mathematics teachers dealt with geometry and spatial sense, 28 percent focused on algebra, and 26 percent focused on patterns and relationships. A number of other areas—data collection and analysis, functions and pre-calculus concepts, numeration and number theory, statistics, pre-algebra, measurement, computation, mathematics as a way of knowing, and probability—were each the focus in 15 percent or fewer of the 6–12 mathematics content sessions.

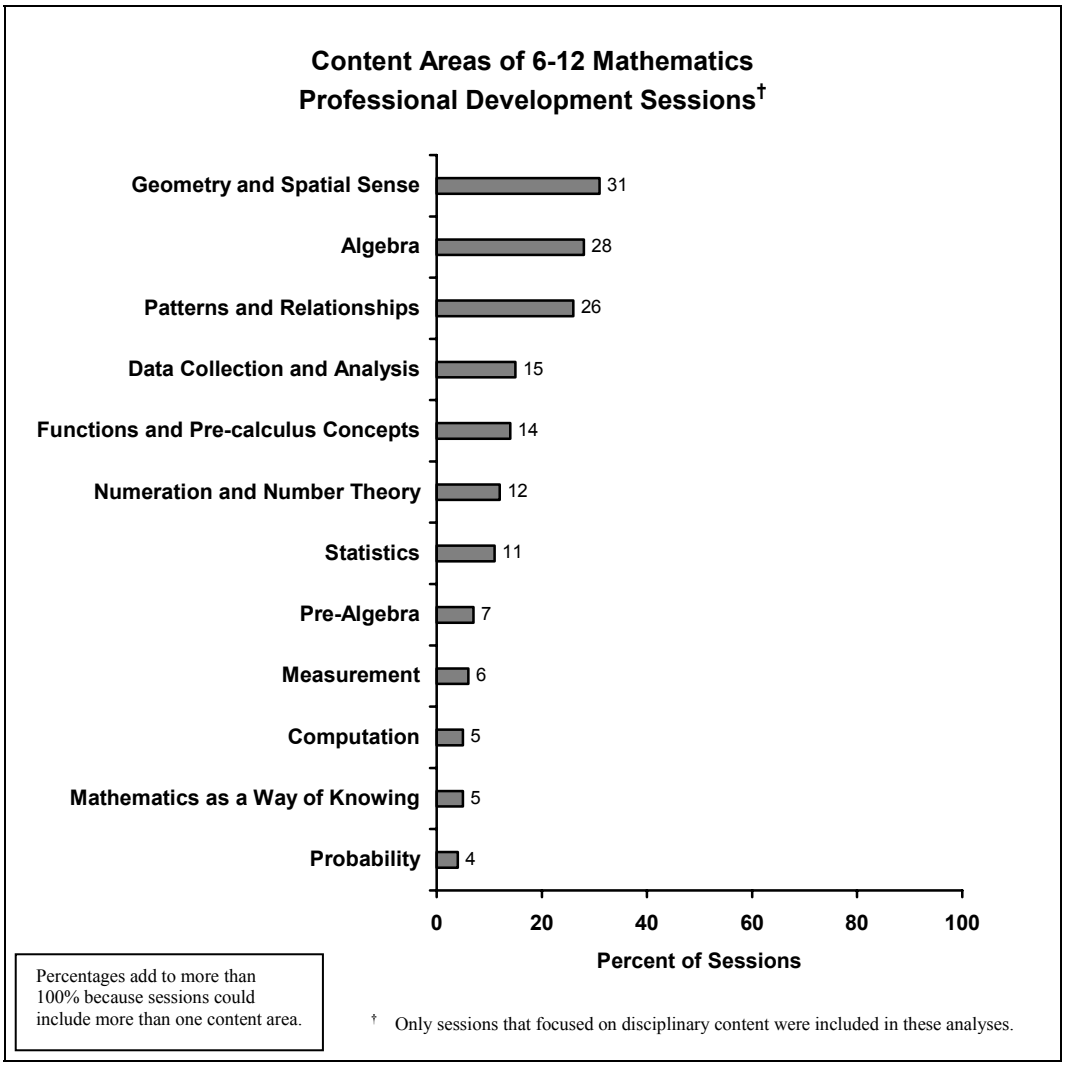

Figure 8

Session Activities

The typical professional development session observed as part of the LSC core evaluation included several different types of activities. As can be seen in Table 4, most sessions included discussions or seminars (76 percent) and engaged participants in problem-solving or investigation (66 percent). Thirty-four percent of the sessions included formal presentations, usually by project staff as opposed to participants. Relatively few of the observed sessions involved participants in reading (6 percent) or writing (2 percent) about disciplinary content, pedagogy or reform issues.

Table 4
Major Activities of LSC Professional Development Sessions

	Percent of Sessions				
	All Sessions	Science		Mathematics	
		K–8	6–12	K–8	6–12
Engaged in discussions/seminars	**76**	**59**	**94**	**82**	**80**
Whole group led by facilitator	60	46	77	62	70
Small groups/pairs	36	28	58	36	36
Whole group led by participants	13	1	25	13	27
Engaged in problem-solving/investigation	**66**	**66**	**60**	**62**	**78**
Listened to a formal presentation	**34**	**34**	**61**	**27**	**25**
By presenter/facilitator	32	31	51	27	25
By participants	4	3	18	0	0
Read about disciplinary content, pedagogy, or reform issues	**6**	**4**	**12**	**6**	**6**
Wrote about disciplinary content, pedagogy, or reform issues	**2**	**2**	**3**	**0**	**4**

C. Quality of LSC Professional Development Sessions

In order to assess the quality of professional development sessions, evaluators were asked to rate a number of components for each session they observed, including the:

- Design of the session;
- Implementation of the professional development activities;
- Quality of the disciplinary, pedagogical, and/or leadership content; and
- Culture of the session.

For each component area, observers first rated a series of individual indicators of best practice in professional development for standards-based mathematics/science education. These indicators were rated on a scale ranging from 1, "not at all" to 5, "to a great extent" to document the extent to which that feature characterized the observed professional development session.

Considering those indicators, observers then assessed the overall quality of each component area. The lowest rating for component areas (Level l) indicated that the session was not at all reflective of best practice. The highest rating (Level 5) indicated that the particular component of the session was extremely reflective of best practices for standards-based mathematics and science education.[8] Evaluators' ratings of the component areas are presented in the following sections.

[8] Copies of the Professional Development Observation Protocol may be found in the Data Collection Manual section of the HRI web site: http://www.horizon-research.com/LSC.

Design of Professional Development Sessions
As noted above, observers assessed the design of professional development sessions by rating a series of individual indicators based on current understandings of best practice. Several of these indicators received high ratings (4 or 5 on a five-point scale) in many of the observed sessions. Those indicators that were most often highly rated included:

- The extent to which the session encouraged a collaborative approach to learning (84 percent); and

- The extent to which the session design provided opportunities for teachers to consider classroom applications of resources, strategies, and techniques (83 percent).

Fewer sessions were rated highly on:

- The extent to which the session included "framing" the activity to help participants understand the purpose of the session and where it fits into the larger professional development picture (73 percent);

- The extent to which the session provided adequate time and structure for "sense-making" (66 percent); and

- The extent to which the session provided adequate time and structure for wrap-up (64 percent).

Overall observers found that the designs of the majority of the professional development sessions were generally reflective of best practice. As indicated in Figure 9, 77 percent of the professional development sessions received overall design ratings of 4 or 5.

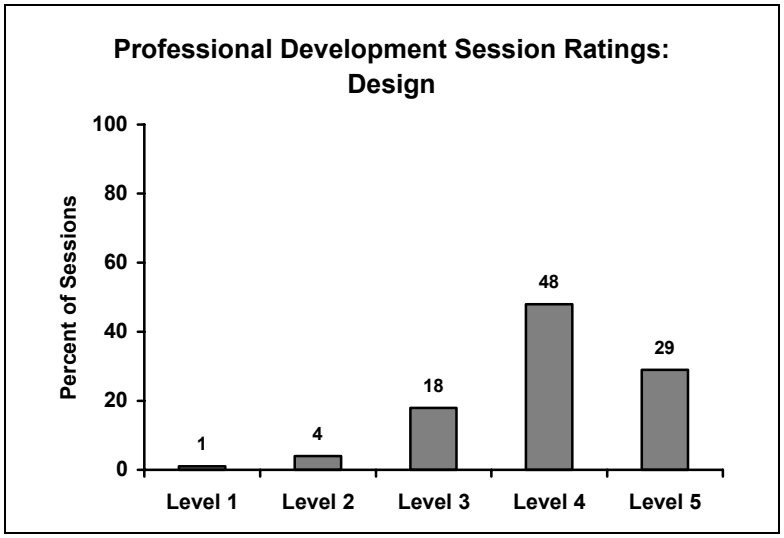

Figure 9

Implementation of Professional Development Sessions
Observers also assessed the quality of implementation of professional development sessions. Indicators most frequently receiving high ratings included:

- The extent to which the facilitators' backgrounds and/or expertise enhanced the quality of the session (82 percent);

- The extent to which the facilitators' contributions during the course of the session enhanced the quality of the session (78 percent); and

As has been the case in previous years, fewer LSC professional development sessions were rated highly on such indicators as:

- The extent to which the session modeled effective assessment strategies (66 percent); and

- The extent to which the facilitators modeled questioning strategies that are likely to enhance the development of conceptual understanding (58 percent).

As indicated in Figure 10, 69 percent of the sessions received overall ratings of 4 or 5 on their quality of implementation.

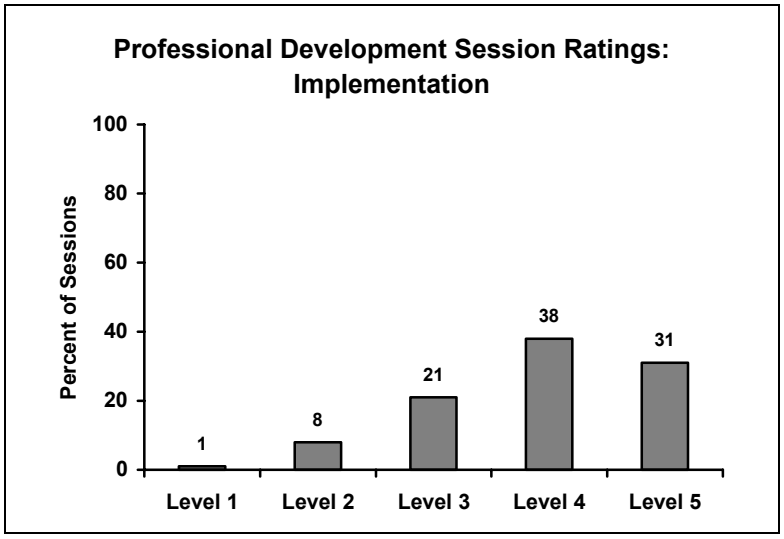

Figure 10

Culture of Professional Development Sessions
The literature on effective staff development emphasizes the importance of establishing a professional development culture where teachers can explore content and pedagogy in a collegial, risk-free environment. As can be seen in Figure 11, 82 percent of the sessions received synthesis ratings of 4 or 5 in this area. Indicators that were most likely to receive high ratings included:

- The extent to which there was a climate of respect for participants' experiences, ideas, and contributions (91 percent); and

- The extent to which active participation of all was encouraged and valued (88 percent).

Fewer sessions were rated highly on:

- The extent to which intellectual rigor, constructive criticism, and the challenging of ideas were evident (76 percent);

- The extent to which participants were encouraged to generate ideas, questions, conjectures, and propositions (76 percent); and

- The extent to which participants demonstrated a willingness to share ideas and take intellectual risks (62 percent).

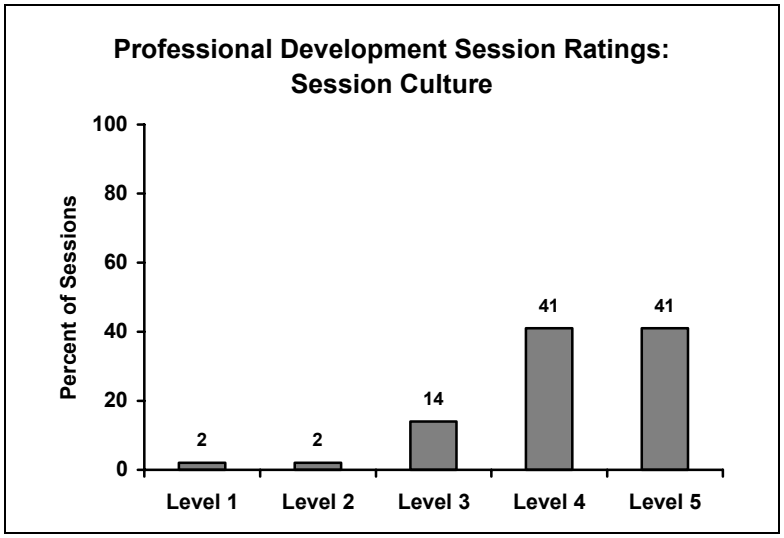

Figure 11

Disciplinary and Pedagogical Content of Professional Development Sessions
Evaluators were asked to rate either the quality of the disciplinary content of the observed session, its pedagogical content, or both, depending on the focus of the session. Disciplinary content was rated in 170 of the 233 sessions, with 67 percent of these sessions receiving overall ratings of 4 or 5 in this area. (See Figure 12.) Indicators for disciplinary content that were most likely to receive high ratings included:

- The appropriateness of the disciplinary content for the purposes of the session and the backgrounds of the participants (84 percent); and

- The extent to which the facilitators displayed an understanding of mathematics/science content (79 percent).

Fewer sessions received high ratings on:

- The extent to which appropriate connections were made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts (64 percent); and

- The extent to which elements of mathematical/science abstraction were included when it was important to do so (61 percent).

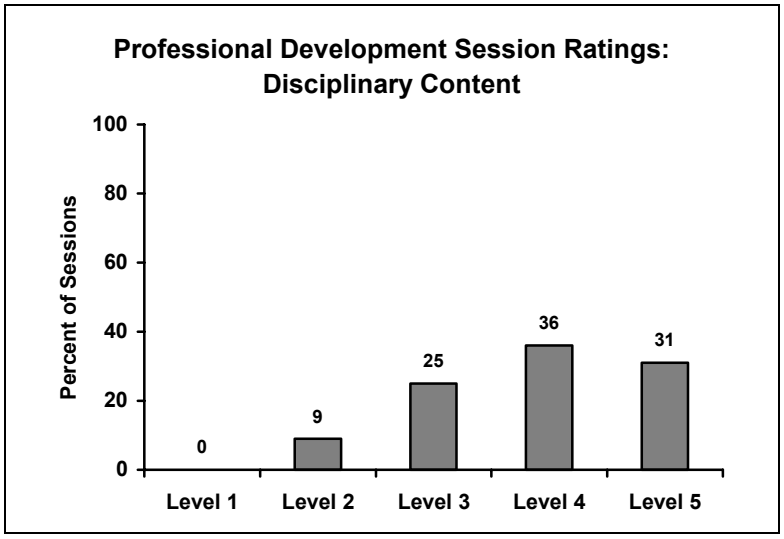

Figure 12

Observers rated 193 of the 233 observed professional development sessions on the quality of their pedagogical content. As can be seen in Figure 13, 66 percent of those professional development sessions received ratings of 4 or 5 for overall pedagogical content.

Within the area of pedagogical content, sessions were rated most highly for:

- The extent to which the facilitators displayed an understanding of pedagogical concepts (81 percent); and

- The extent to which the depth and breadth of attention to instructional materials intended for classroom use were appropriate for the purposes of the session and participants' needs (81 percent).

Similarly to previous years, fewer sessions received high ratings for:

- The extent to which participants were intellectually engaged with important ideas relevant to classroom practice (67 percent);

- The extent to which depth and breadth of attention to student thinking/learning were appropriate for the purposes of the session and participants' needs (66 percent); and

- The extent to which "sense-making" about classroom practice was appropriate for the purpose of the session and the needs of adult learners (59 percent).

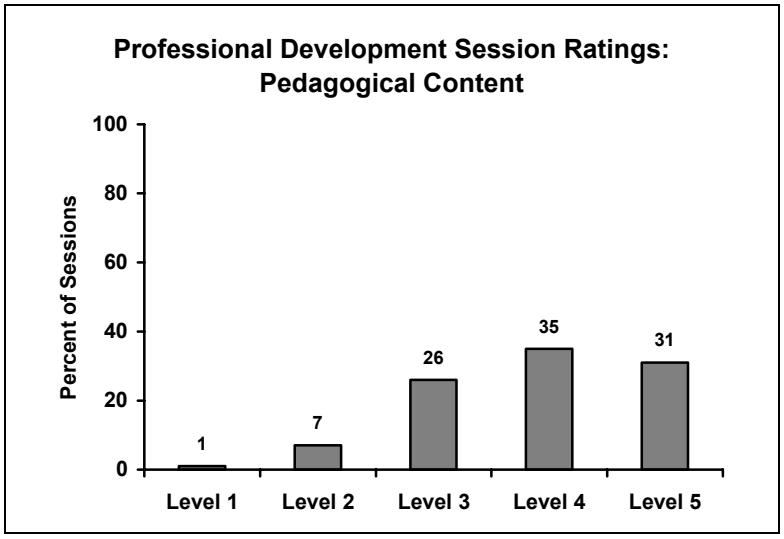

Figure 13

Overall Assessment of Observed Professional Development Sessions
In addition to rating the quality of the professional development session in terms of its components, observers were asked to assess the overall quality of each session. First they considered the likely impact of the session on participants' capacity for exemplary mathematics/science instruction, or the likely impact on leadership capacity when leadership development was a focus of the session instruction. They then assigned a "capsule rating" to characterize the overall quality of the professional development session. Ratings on a five-point scale ranged from "ineffective professional development" (Level 1) to "exemplary professional development" (Level 5).

Impact on Participants' Capacity for Exemplary Mathematics/Science Instruction
Observers rated the likely impact of each session on teachers' capacity for exemplary mathematics/science instruction. According to these observers, LSC professional development sessions were most likely to have a positive effect on participants' abilities to network with other teachers about instruction (80 percent). Fewer sessions were judged likely to have a positive effect on participants' ability to use the designated instructional materials to develop students' conceptual understanding (71 percent), ability to identify and understand important ideas of mathematics/science (71 percent), ability to use the designated instructional materials to develop students' conceptual understanding (71 percent), and understanding of how students learn (69 percent). This latter area also has been rated least highly in previous years.

Quality of Leadership Development Sessions
Many LSC projects incorporate the use of teacher leaders in their professional development strategies. When evaluators observed professional development sessions that focused on the preparation of teacher leaders, as did 23 of the 233 observed sessions, they were asked to rate a number of applicable key indicators in the area of leadership content. As can be seen in Figure 14, 62 percent of the sessions focusing on leadership content received a high synthesis rating (4 or 5) in this area.

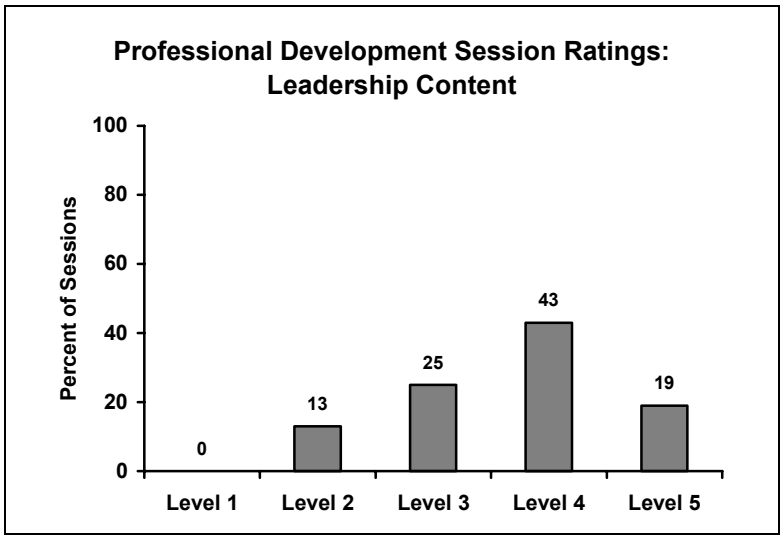

Figure 14

When asked about the likely impact of the sessions on participants' leadership capacity, each of the following areas was rated as likely to have a positive impact in 80 percent or more of the sessions: leaders' knowledge and understanding of effective classroom practice; leaders' understanding of important strategies for reform of mathematics/science education; participants' confidence in serving in leadership roles; and professional networking among participants with regard to leadership roles. Only 56 percent of leadership sessions were judged likely to have a positive effect on teacher leaders' understanding of adult learners.

Capsule Ratings of Observed Professional Development Sessions

As would be expected given the high ratings assigned by evaluators for the various components, overall ratings for individual professional development sessions were quite favorable. Only 1 percent of observed LSC sessions were rated as ineffective professional development (Level 1), and 6 percent were rated at Level 2, having quite limited likelihood of helping participants implement exemplary mathematics/science instruction or be leaders in reform. Overall, 61 percent of the observed professional development sessions received ratings of 4 or 5, indicating that those sessions were skillfully facilitated, engaging participants in purposeful work that would likely lead to enhanced capacity to implement exemplary instruction. (See Figure 15.)

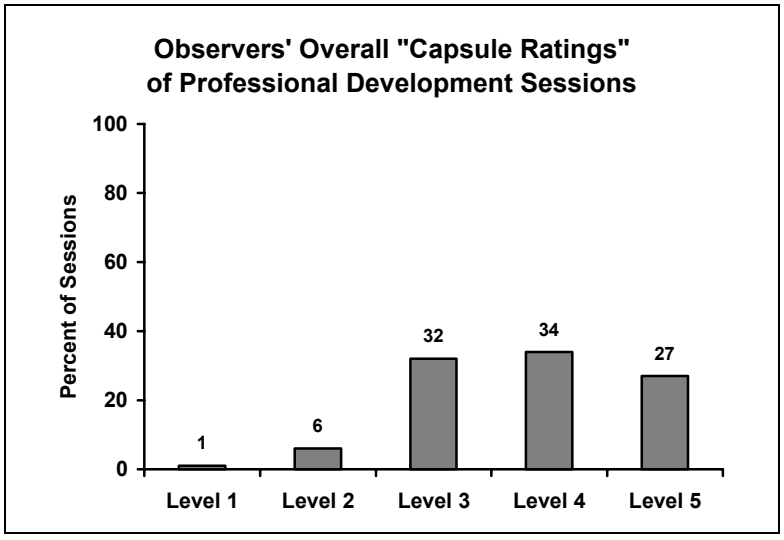

Figure 15

D. Teacher Perceptions of the Overall Quality of LSC Professional Development Programs

As part of the core evaluation, each year a sample of teachers is asked about the overall quality of the LSC professional development. In the spring of 2003, 414 teachers who had participated in 20 hours or more of LSC professional development were interviewed by project evaluators. In addition, 5,184 teachers who had participated in LSC professional development answered survey questions about the quality of those experiences.

Teachers who indicated they had participated in LSC professional development were asked to respond to a series of statements about those experiences. Table 5 shows that overall, fewer than one third of the teachers who have participated in the LSC indicated that they were given considerable time to work with other teachers and to reflect on how to apply what they are learning to their classrooms. Teachers were somewhat more likely to indicate that they receive considerable support for implementation, with 46 percent doing so.

Table 5
Teachers Agreeing† to Statements about LSC Professional Development

	Percent of Teachers				
	All Teachers	Science		Mathematics	
		K–8	6–12	K–8	6–12
I receive support as I try to implement what I've learned.	46	43	46	50	43
I am given time to work with other teachers as part of my professional development.	32	29	29	37	29
I am given time to reflect on what I've learned and how to apply it to the classroom.	29	25	25	34	26

† Includes teachers indicating 4 or 5 on a five-point scale ranging from 1 "not at all" to 5 "to a great extent."

Table 6 shows teacher ratings of LSC professional development programs overall, with 7 percent of teachers rating the professional development programs "poor" or "very poor," 54 percent "fair" or "good," and 39 percent "very good" or "excellent."

Table 6
Teacher Ratings of LSC Professional Development Programs Overall

	Percent of Teachers				
	All Teachers	Science		Mathematics	
		K–8	6–12	K–8	6–12
Very Poor	2	1	6	2	2
Poor	5	3	14	4	7
Fair	23	20	22	23	27
Good	31	31	27	32	32
Very Good	26	31	22	24	24
Excellent	13	15	8	15	8

Figure 16 shows the percentage of teachers in each of the subject and grade range combinations who rated LSC professional development "excellent" or "very good" in the 2003 questionnaire, analyzed by level of treatment. Note that the greater the level of participation, the higher the ratings. Similarly, Figure 17 shows the results on a composite variable on quality of the LSC professional development created from teachers' responses to several items on the questionnaire.[9] Again, the more hours of participation in LSC professional development, the higher the ratings of quality. In both cases, it is not possible to tell from these data whether teachers appreciate the professional development to a greater extent after having experienced more of it, or if the teachers who consider the professional development of high quality are more likely to participate in multiple professional development activities.

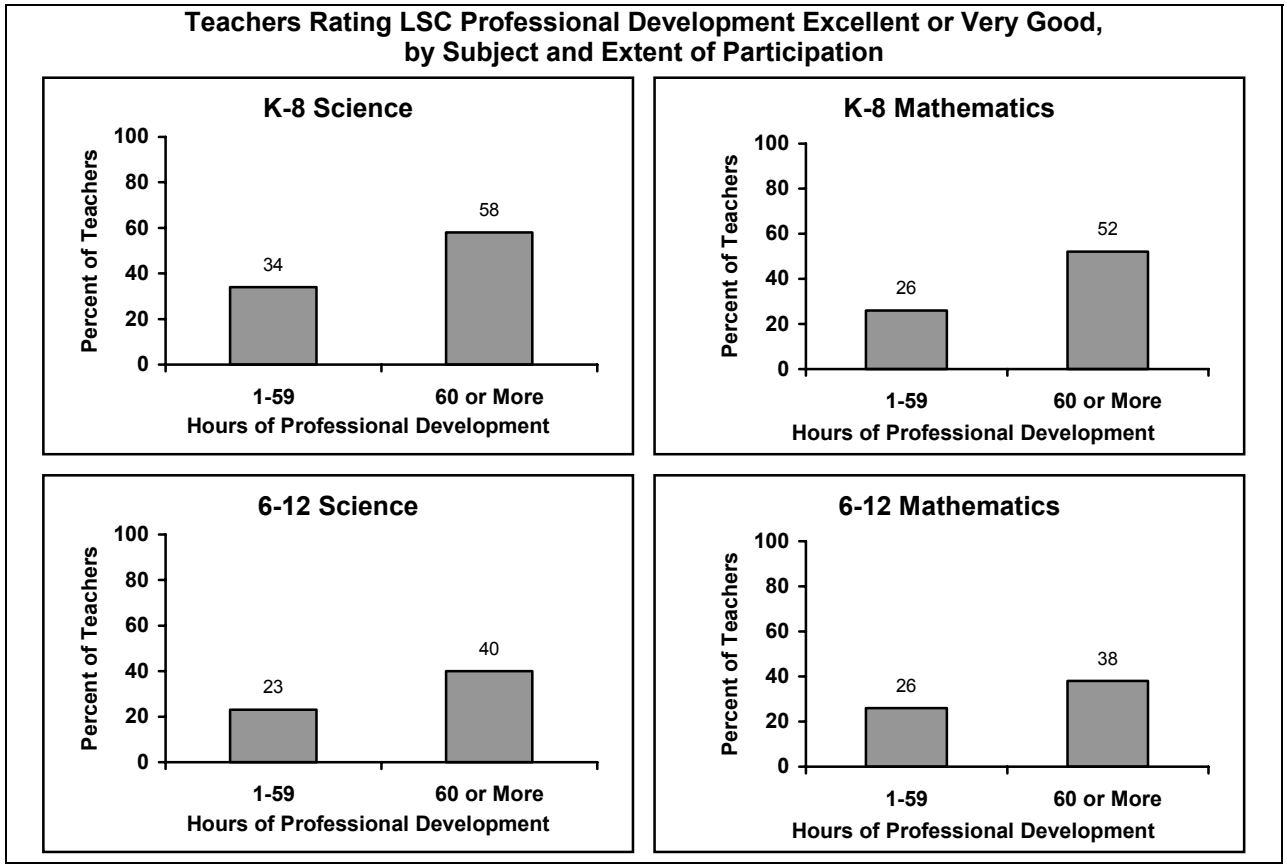

Figure 16

[9] See Data Analysis in Section I for a description of how composite scores were calculated.

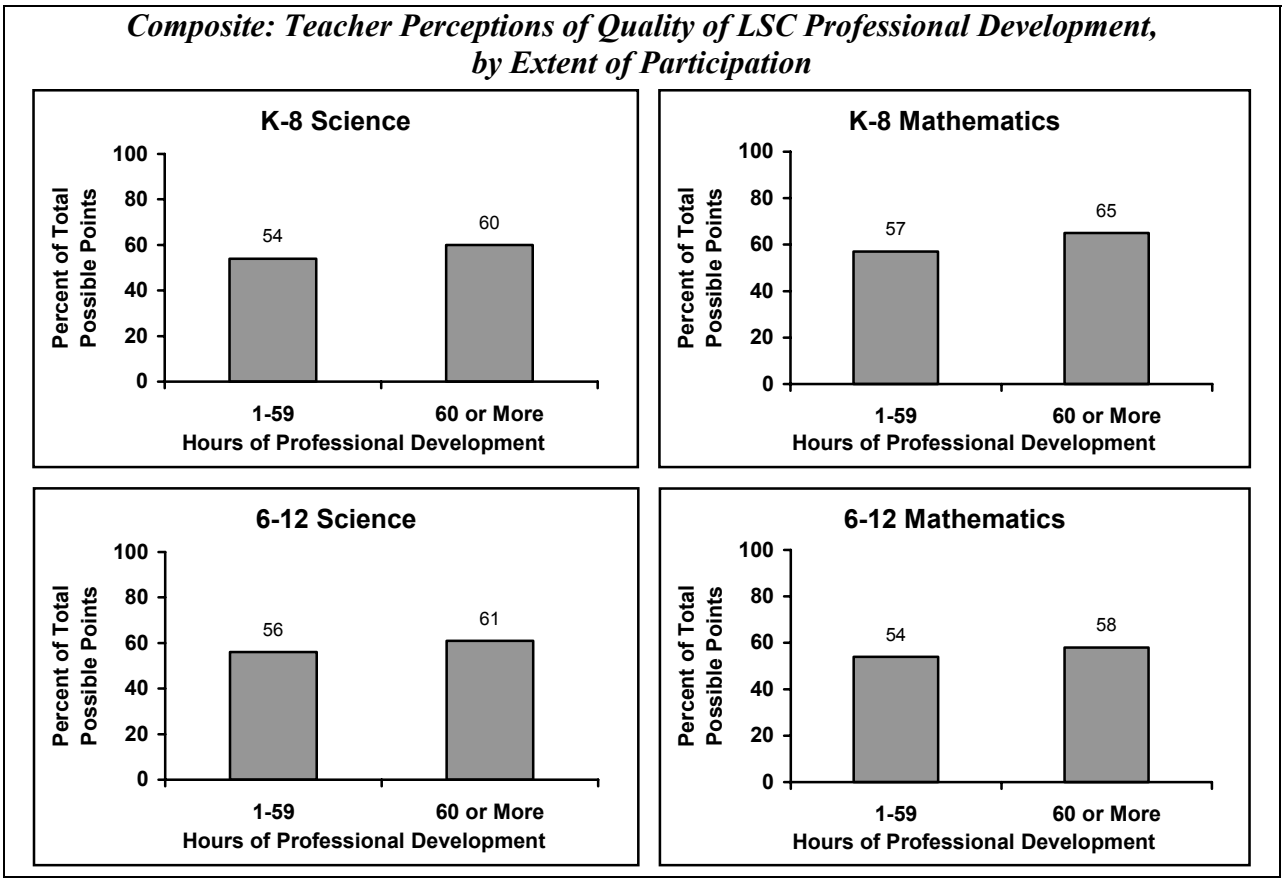

Figure 17

Teacher interviews yield similar findings. Evaluators asked a random sample of teachers who had participated in at least 20 hours of LSC professional development to talk about their experiences in the program and used these responses to characterize each teacher's opinions on a five-point scale from very negative to very positive. Overall, 58 percent of teachers who had participated in LSC professional development had highly positive opinions of the LSC program and only one percent had highly negative opinions.

When asked about the impact of the LSC, nearly three-quarters of teachers talked about how the LSC had enabled them to change their classroom practice, and half spoke about how the LSC had made them better prepared for mathematics/science teaching. Interestingly, more teachers cited improvements in relation to their instructional strategies and use of the designated materials than cited improvements related to content, either their own content knowledge or the content of their classroom instruction. Typical comments concerning changed classroom practice and increased preparedness follow.

Changed Classroom Practice

It has broadened my knowledge of science and given me an opportunity to work with the kids hands-on. They actually have materials in the kit that they can see and feel and try to come up with their own conclusions. It also increases discussion among the whole classroom, why we came up with a certain conclusion…We work in groups and each group comes together at the end to discuss their findings. (K–8 Science Teacher)

I use much more inquiry-based teaching methods than "let's read the book." I ask more open-ended questions and require more investigation and leading from the students. I answer much fewer questions without them doing some research first. I watch the children find their own answers. (K–8 Science Teacher)

When I started teaching, I was very traditional, I did too much lecturing. Now I will say, depending on the topic, maybe once a week I'll do a traditional lecture, and the remainder of the week I will have activities for them to work on where they'll work in little groups and get the information on their own, or whatever the activity calls for. So year, [project name] has definitely changed by approach to teaching…that's where I learned the techniques of cooperative learning and inquiry. (6–12 Science Teacher)

Before [project name], I was more focused on the right answer. For example, in 2nd grade with double-digit subtractions and addition with regrouping: before [project name], I taught it only one way. You could start at the ones and you could only borrow from the tens. Now, I'm more willing to listen to children and more willing to use the cubes and talk about how you did it and how you thought about it and to get them to share about it. Now, even though there is a right answer, there are a lot of different ways to get there and that's okay. (K–8 Mathematics Teacher)

I used to teach the "old" way before Investigations*. Within the three years I made a transition. More towards thinking, finding other ways to solve problems, and having the children explaining how they are solving the problems.* (K–8 Mathematics Teacher)

I was taught very traditionally and began my teaching career very traditionally: read the page, do the problems on this page, here is a worksheet to do for homework. I've done a 180 degree turn as far as what math instruction really is. Rather than me telling everything, the kids figure stuff out – a much more open-ended approach is how I teach…I use a lot more open-ended type activities, I think I have more wait time, I have more patience letting them struggle through finding an answer rather than when they say "I don't get it" just starting to help them right away. (6–12 Mathematics Teacher)

It's made me aware of how to use the components of the program effectively, for example the pacing for students not on grade level and also group work…Overall, I've moved away from a traditional teacher who is telling all to a teacher who coaches and students who explore and discover and problem solve on their own. (6–12 Mathematics Teacher)

Increased Preparedness

> *I think it has helped most in two areas. The first area is just knowing the content as an adult learner. So knowing it a little more in depth than I would need to in order to teach it to third graders. But I think, for me, the more I learn, the more I want to know. So it has been motivating for me in that respect. And then I think also, in a lot of the [project name] programs that I participated in, there is time to reflect on sort of the children's understanding, at whatever level they're at, and that has been really helpful to me, because even as an adult learner some of these concepts are pretty tricky.* (K–8 Science Teacher)

> *I mostly teach earth science, and since I hadn't taken any previous courses in that areas, the content course helped me a lot.* (6–12 Science Teacher)

> *This has made my practice better. I have better resources and now know how to use them. It helped me to understand the material and I have better knowledge of the tools. I am more the facilitator rather than a dominating teacher.* (K–8 Mathematics Teacher)

> *I am much more knowledgeable about my understanding of mathematics, I am far better able to understand children's mathematics thinking, and I am more confident as a teacher of mathematics which transfers directly to my students.* (6–12 Mathematics Teacher)

When asked about the "most helpful" aspects of the LSC, nearly half of the teachers mentioned the opportunity to deepen their knowledge and 37 percent identified the high quality of professional development. Slightly more than one-third of the teachers cited collaborating/networking with other teachers, and a similar proportion cited getting materials needed for instruction. About one-quarter of the teachers talked about the opportunities to deepen their knowledge of pedagogy and how to use the designated instructional materials. Science teachers were more likely than mathematics teachers to talk about the utility of the LSC in helping them understand content and providing them with materials needed for instruction, while mathematics teachers were more likely to cite collaborating/networking with other teachers as the "most helpful" aspect of the LSC.

Problems with the designated instructional materials, mentioned by 29 percent of the teachers, topped the list of "least helpful" aspects of the LSC, particularly the time required to implement the materials and the logistics of materials management:

> *The butterfly kit came three weeks late. The caterpillars arrived on the Thursday before Good Friday. When we came back on Monday, three were in chrysalis. I haven't had time to do the unit right because of the timing of when the kit arrived, so I have had to go through it too quickly. The caterpillars were so large that some of them had died, so not all of the kids got one. I love this unit, it's just going too quickly. I had to get to the 6th lesson in three days.* (K–8 Science Teacher)

The last training was least helpful because we don't have the materials to teach with. The trainer would refer to a booklet that our students do not have. (K–8 Mathematics Teacher)

There are some difficulties in the curriculum, the modules, because of the amount of preparation in takes. (6–12 Science Teacher)

Others expressed concern about the quality or applicability of the professional development and the time commitment required:

The instructor was way over our heads. I guess it really turned me off…What the scientist taught was so far over our heads. (K–8 Science Teacher)

They just walked us through the lessons and showed us the materials that go with it. We could have done that on our own. We need somebody who knows the challenges and can show us what to watch out for. (6–12 Science Teacher)

Probably we could have used a little less professional development. The times that we met were good, but it was near report card time. I know I felt I could have used more time in my class. So in one way it was good, but in the other way it felt time consuming. (K–8 Mathematics Teacher)

When asked about needs for additional help in improving instruction, teachers typically requested "more" of what they were already getting: more readily available materials or supplies, more professional development in pedagogy and in the use of the designated materials, more professional development in mathematics/science content, and more time for networking with other teachers. Typical comments included:

I would like to see at my school a well-organized science room with materials. I was planning on doing this this year, but with teaching full time it's been impossible. Materials that would support other activities…also, more materials in Spanish. (K–8 Science Teacher)

I need more science content courses, more ideas about how to teach lessons, more ideas for hands-on activities, more work with colleagues. (6–12 Science Teacher)

More professional development, more materials…I would like a weekly meeting with a staff developer like we do with literacy. (K–8 Mathematics Teacher)

I'd like to have the study groups operating on a consistent basis during the school day. I'd like help with pedagogy, how to teach a variety of topics, another way to motivate students, strategies for using manipulatives. (6–12 Mathematics Teacher)

E. Evaluator Ratings of the Quality of LSC Professional Development Programs

Based on the results of their observations, as well as feedback from participating teachers, evaluators rated the overall quality of the LSC professional development in a number of areas, including preparing project staff to carry out their roles in providing professional development to targeted teachers, the quality of the professional development culture, the project's overall treatment of disciplinary content, instructional materials and pedagogy, and the nature and extent of support provided to teachers during implementation.

Preparedness of Professional Development Providers

As can be seen in Figure 18, overall, 85 percent of LSC projects received high ratings (4 or 5 on a five-point scale ranging from 1 "inhibited effective professional development" to 5 "facilitated effective professional development") for the quality of their efforts in preparing professional development providers.

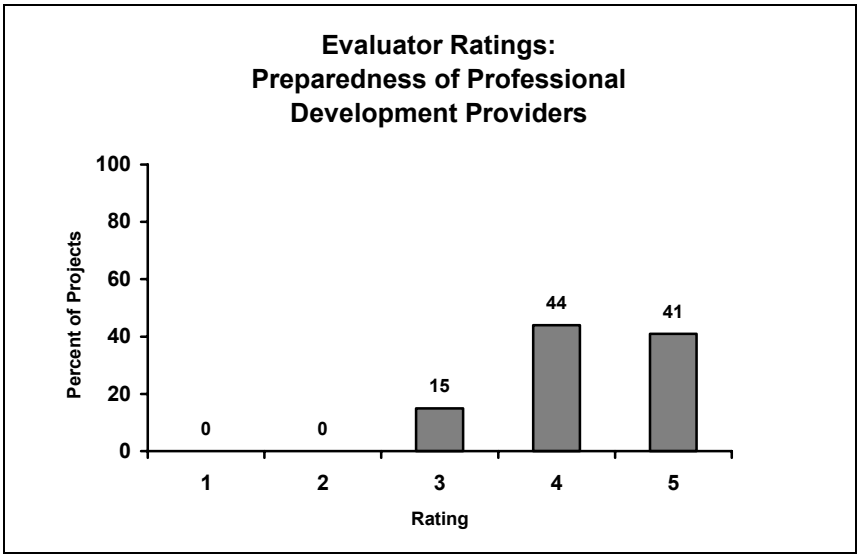

Figure 18

Professional Development Culture

Using all of the information available to them, including teacher comments and their own observations, evaluators rated the overall success of each project in creating a climate conducive to teacher learning. Overall, 89 percent of projects received ratings of 4 or 5 in this area. (See Figure 19.)

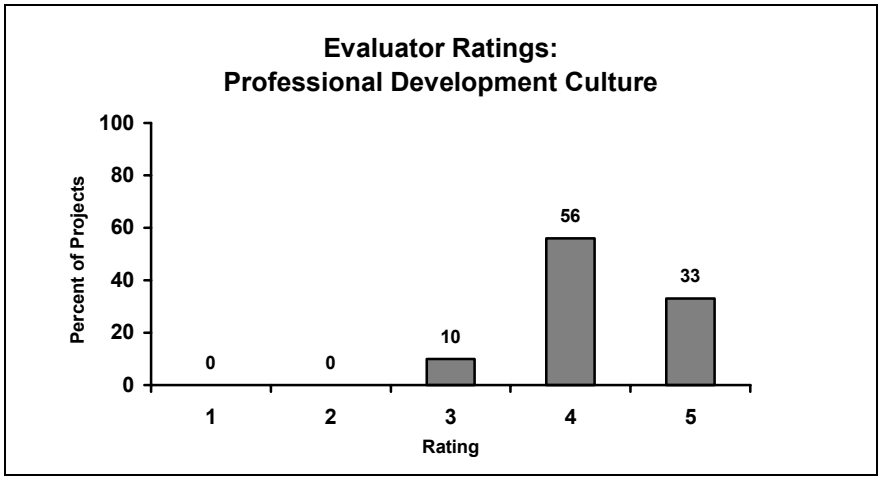

Figure 19

Treatment of Disciplinary Content

When they prepared their annual reports, evaluators considered the data they had from observations, interviews, and questionnaires and came up with an overall rating of the quality of the project's treatment of disciplinary content. As can be seen in Figure 20, only 46 percent of projects received high ratings (4 or 5 on a five-point scale ranging from 1 "poor" to 5 "excellent") in this area.

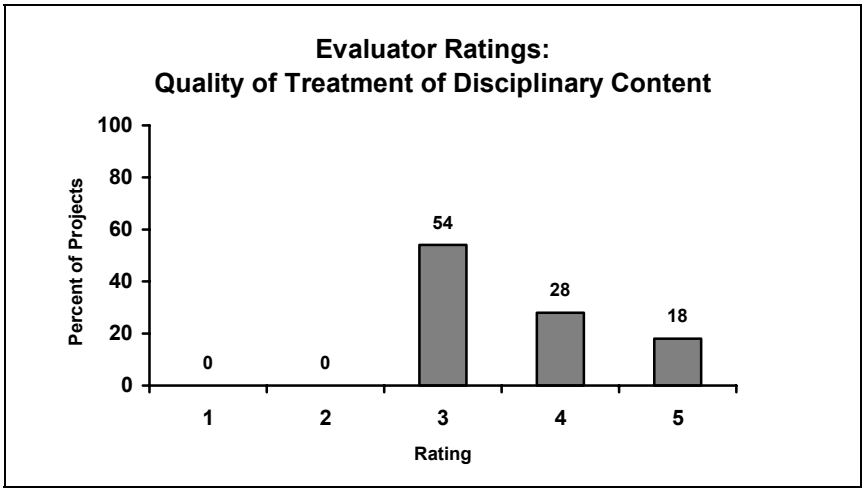

Figure 20

Treatment of Instructional Materials and Pedagogy

In addition to describing the quality of the project's treatment of the designated instructional materials and pedagogy, evaluators were asked to provide overall ratings in this area. As can be seen in Figure 21, 69 percent of projects received ratings of 4 or 5 in this area, markedly higher than the 46 percent in developing disciplinary content.

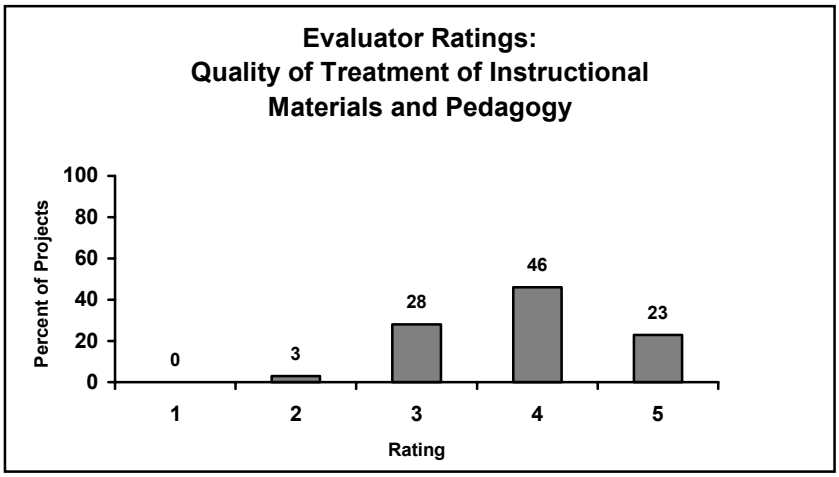

Figure 21

Support for Teachers During Implementation

Based on interview, observation, and questionnaire data, evaluators provided an overall rating of the quality of the support provided to teachers as they implemented the instructional materials in their classrooms. As can be seen in Figure 22, overall, only 47 percent of projects received high ratings in this area; 8 percent received a rating below 3 on a five-point scale.

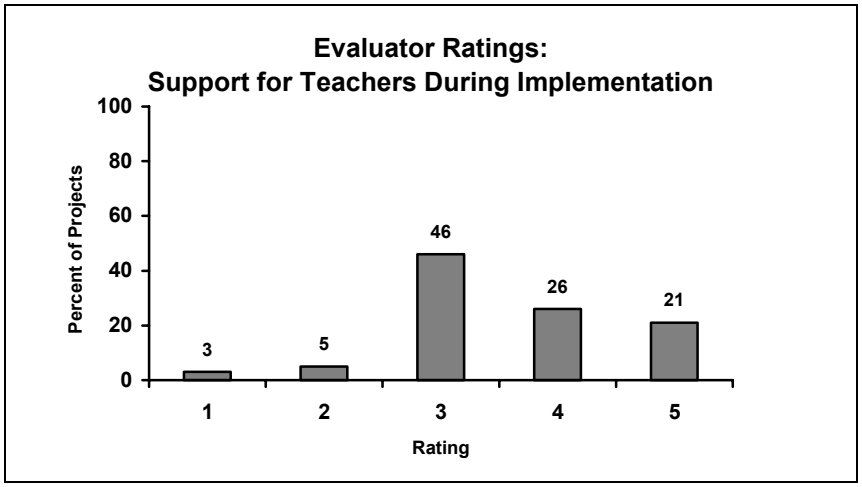

Figure 22

Continuum Ratings

At the close of the data collection year, evaluators were asked to use all of the information available to them to place the project on a continuum, from predominance of ineffective professional development, through various stages of improvement, to a system of predominantly well-designed professional development**.** As can be seen in Table 7, most LSC projects were rated as either transitioning to quality professional development or having an emerging infrastructure of well-designed professional development; none were rated at the two lowest levels.

Table 7
Continuum Ratings for Quality of LSC Professional Development

	Percent of Projects[†]				
	All Projects	Science		Mathematics	
		K–8	6–12	K–8	6–12
Level 1: Predominance of Ineffective Professional Development	0	0	0	0	0
Level 2: Exploring Quality Professional Development	0	0	0	0	0
Level 3: Transitioning to Quality Professional Development	44	53	57	43	38
Level 4: Emerging Infrastructure of Well-Designed Professional Development	38	40	14	36	50
Level 5: Predominance of Well-Designed Professional Development	18	7	29	21	13
Mean Continuum Rating Level	3.7	3.5	3.7	3.8	3.7

[†] Projects that address two subject areas are included in each subject, but counted only once in the total of all projects.

III. Impact of the LSC on Teacher Preparedness, Attitudes, and Beliefs

The "theory of action" underlying the Local Systemic Change initiative argues that providing teachers with well-designed opportunities to appreciate standards-based reform and deepen their content and pedagogical knowledge in the context of high-quality instructional materials will result in better prepared teachers. When these teachers are also given support in using these instructional materials, the theory predicts, they will be both inclined to change their teaching in ways advocated by national standards, and have the capability of doing so. Improved instruction, in turn, will lead to higher student achievement.

Participating in LSC professional development impacted teachers' attitudes and beliefs about mathematics/science education in a variety of ways, prompting them to re-evaluate their own practice as well as their perceptions about mathematics and science teaching. The reflection time built into high-quality professional development sessions gave teachers the opportunity to process what they had learned about content and pedagogy, and to examine their evolving beliefs about teaching and learning. Still, many teachers continue to feel under-prepared in these areas.

Teacher questionnaire data indicate that in both science and mathematics, teachers who have participated in LSC professional development are less likely to support ability grouping than those who had not yet participated. (See Figure 23.)

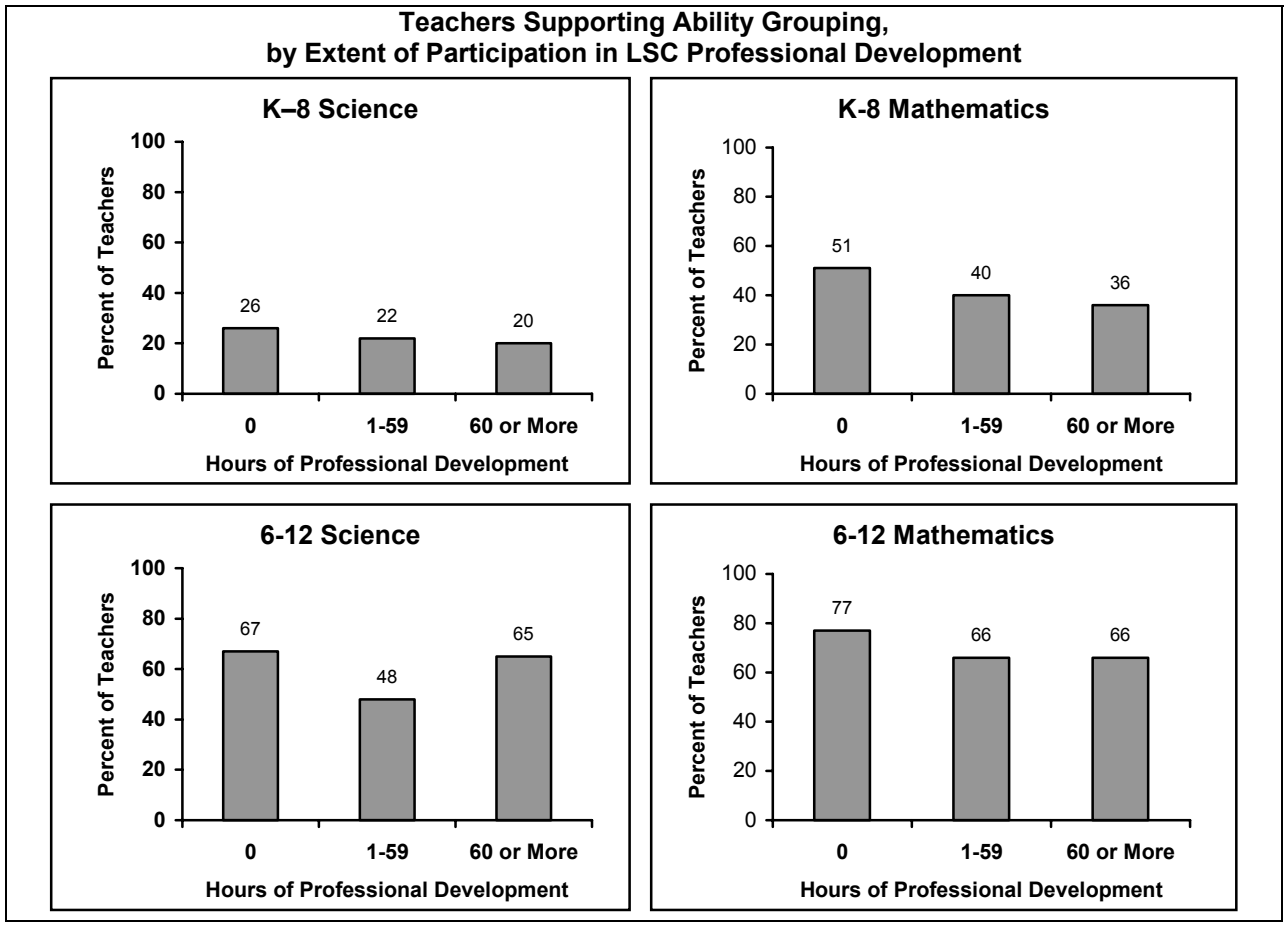

Figure 23

Results on a composite of several items related to teachers' attitudes toward standards-based teaching indicated a small positive effect for elementary mathematics teachers, with the most highly-treated group having more reform-oriented attitudes than do untreated teachers. (See Figure 24.) The effect sizes, and the data used to calculate them, for all comparisons on the composites are included in the Appendix.[10] There are no significant differences between highly treated teachers and untreated teachers on this composite for the other subject/grade-range combinations.

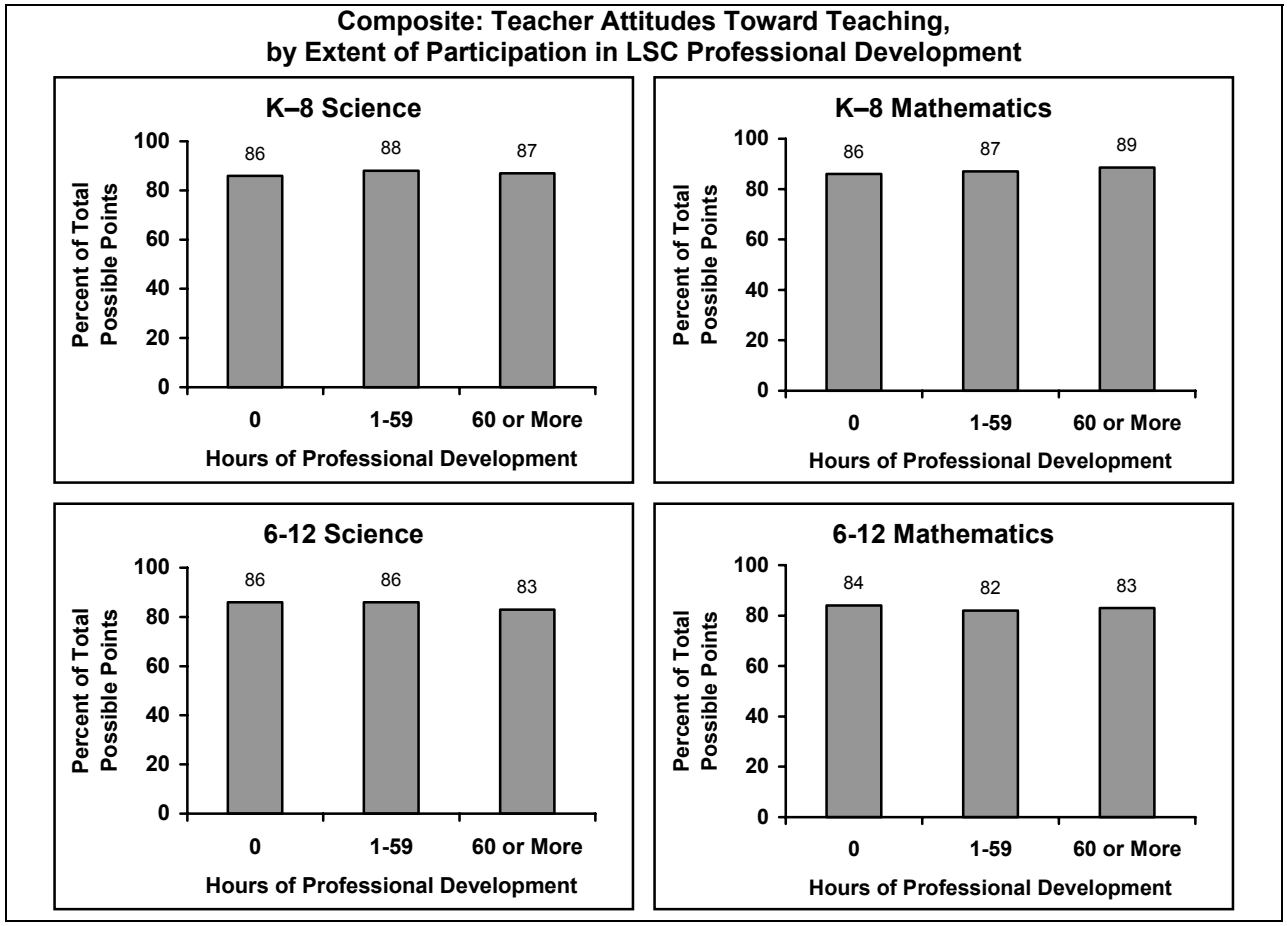

Figure 24

Participating in LSC professional development appears to have had a substantial impact on elementary teachers' feelings of preparedness to teach science. As can be seen in Figure 25, 84 percent of K–8 science teachers who had participated in at least 60 hours of LSC professional development indicated they were at least fairly well prepared to teach science, compared to 66 percent of those who had not yet participated in LSC professional development.

[10] The effect size, d, is calculated as the difference between the "0 hours" and "60 or more hours" group means, divided by the pooled standard deviation. Following standard conventions, effect sizes of 0.2 are considered small effects, 0.5 medium effects, and 0.8 large effects (Jacob Cohen, *Statistical Power Analysis for the Behavior Sciences,* Hillsdale, NJ: Lawrence Erlbaum Associates, 1988).

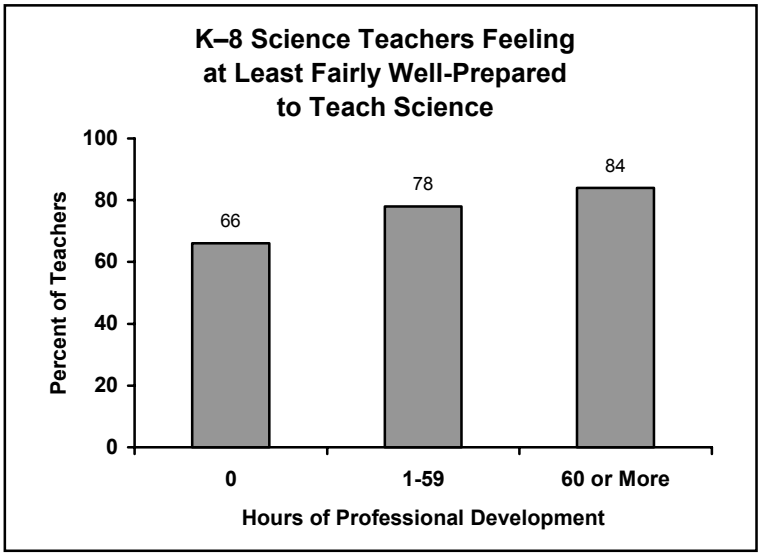

Figure 25

In mathematics, 88 percent of teachers in K–8 projects who had not yet received LSC professional development indicated they were at least fairly well prepared to teach mathematics, so the comparison was made for very well prepared. As can be seen in Figure 26, 58 percent of K–8 mathematics teachers who had participated in at least 60 hours of LSC professional development indicated they were very well prepared to teach mathematics, compared to 43 percent of those who had not yet participated in LSC professional development.

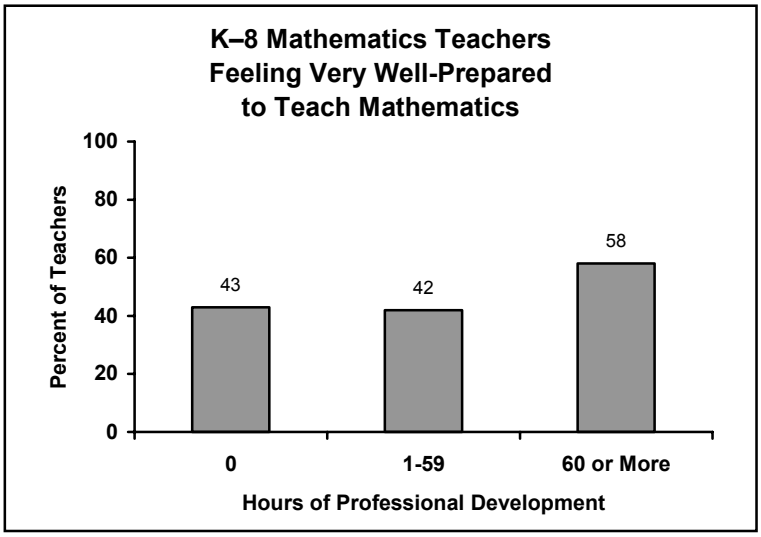

Figure 26

A similar pattern can be seen when teachers were asked about their preparedness to teach specific science and mathematics topics. In K–8 science, there were significant differences between untreated and highly-treated teachers on 7 of the 11 topics listed, with effect sizes[11] ranging from 0.14 to 0.30. (See Table 8.)

Table 8
K–8 Science Teachers Feeling at Least Fairly Well-Prepared† to Teach Each Topic, by Extent of Participation in LSC Professional Development

	Percent of Teachers			
	0 Hours (N = 161)	1–59 Hours (N = 579)	60 or More Hours (N = 580)	Effect Size (h)
The human body	58	66	72	0.29***
Ecology	55	59	61	0.12*
Rocks and soils	48	57	63	0.30*
Astronomy	40	48	47	0.14*
Processes of change over time	38	47	41	0.06
Mixtures and solutions	41	49	51	0.20***
Electricity	33	42	43	0.21**
Sound	36	47	46	0.20
Forces and motion	47	53	52	0.10
Machines	36	40	42	0.12
Engineering and design principles	22	29	32	0.23**

† Includes teachers indicating 3 or 4 on a four-point scale ranging from 1 "not adequately prepared" to 4 "very well prepared."

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (proportion of teachers feeling at least fairly well-prepared in the 60 or more hours group significantly different than in the 0 hours group, RS3-adjusted chi-square, WesVar 4.2).

[11] When comparing percents, the effect size is calculated using the difference between the arcsine transformation of the percents of the "0 hours" and "60 or more hours" groups. Specifically, $h = \varphi_1 - \varphi_2$, where $\varphi = 2*\arcsin(P^{½})$, and P is the proportion of cases in a category.

Participation in LSC professional development also appears to have had an impact on secondary science teachers' perceptions of their content preparedness, with significant differences between untreated and highly-treated teachers in 6 of the 22 topics. (See Table 9.) Interestingly, most of the impacts are in the areas of earth science and scientific methods and inquiry skills. There was little or no impact in the areas of biology, chemistry, physics, and environmental and resource issues, though it is not possible to tell if this result is due to the quality of the professional development in these areas, or if 6–12 science projects simply have not focused on these topics.

Table 9
6–12 Science Teachers Feeling at Least Fairly Well-Prepared† to Teach Each Topic, by Extent of Participation in LSC Professional Development

	Percent of Teachers			
	0 Hours (N = 92)	1–59 Hours (N = 169)	60 or More Hours (N = 151)	Effect Size (h)
Earth Science				
The solar system and the universe	56	64	71	0.31*
Earth's features and physical processes	59	67	73	0.30
Climate and weather	58	64	72	0.29*
Biology				
Animal behavior	76	77	77	0.02
Genetics and evolution	65	72	74	0.20
Interactions of living things/ecology	83	82	87	0.11
Plant biology	72	73	77	0.11
Structure and functions of human systems	81	80	82	0.03
Chemistry				
Properties and states of matter	77	79	95	0.55**
Structure of matter and chemical bonding	66	66	79	0.29
Chemical reactions	66	67	76	0.22
Energy and chemical change	71	70	78	0.16
Physics				
Forces and motion	62	72	76	0.30*
Electricity and magnetism	57	60	57	0.00
Energy	71	70	75	0.09
Light and sound	66	64	65	-0.02
Modern physics (e.g., special relativity)	41	36	34	0.14
Environmental and Resource Issues				
Pollution, acid rain, global warming	74	76	81	0.17
Population, food supply and production	76	74	77	0.02
Scientific Methods and Inquiry Skills				
Describing, graphing, and interpreting data	90	89	98	0.36**
Formulating hypotheses, drawing conclusions, making generalizations	88	92	95	0.26
Experimental design	79	82	88	0.24**

† Includes teachers indicating 3 or 4 on a four-point scale ranging from 1 "not adequately prepared" to 4 "very well prepared."
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (proportion of teachers feeling at least fairly well-prepared in the 60 or more hours group significantly different than in the 0 hours group, RS3-adjusted chi-square, WesVar 4.2).

In K–8 mathematics, teachers with 60 or more hours of LSC professional development were significantly more likely than untreated teachers to indicate that they were at least fairly well-prepared to teach each of 9 of the 11 topics listed, with effect sizes of 0.13 or greater. The largest difference was in data collection and analysis, with an effect size of 0.31. In 6–12 mathematics, there were significant differences between untreated and highly-treated teachers on 10 of the 14 topics listed, with effect sizes ranging from 0.16 to 0.33. (See Table 10.)

Table 10
K–8 and 6–12 Mathematics Teachers Feeling at Least Fairly Well-Prepared† to Teach Each Topic, by Extent of Participation in LSC Professional Development

	Percent of Teachers							
	K–8 Mathematics				6–12 Mathematics			
	0 Hours (N = 380)	1–59 Hours (N = 1,122)	60 or More Hours (N = 1,197)	Effect Size (h)	0 Hours (N = 231)	1–59 Hours (N = 366)	60 or More Hours (N = 475)	Effect Size (h)
Computation	92	93	96	0.17**	—	—	—	—
Numeration and number theory	84	89	92	0.25***	—	—	—	—
Estimation	87	88	93	0.20**	91	93	97	0.26**
Measurement	88	90	92	0.13**	89	93	96	0.27***
Pre-algebra	73	72	76	0.07	88	89	95	0.26**
Algebra	63	61	65	0.04	79	81	85	0.16*
Patterns and relationships	88	93	94	0.21**	88	88	95	0.26***
Geometry and spatial sense	78	83	87	0.24***	81	84	91	0.29**
Data collection and analysis	79	83	90	0.31***	84	86	94	0.33**
Probability	68	68	76	0.18*	77	83	88	0.29**
Technology in support of mathematics	54	56	64	0.20*	56	63	69	0.27***
Functions and pre-calculus concepts	—	—	—	—	54	59	58	0.08
Statistics	—	—	—	—	47	54	55	0.16
Topics from discrete mathematics	—	—	—	—	27	34	36	0.19*
Mathematical structures	—	—	—	—	20	30	23	0.07
Calculus	—	—	—	—	23	32	24	0.02

† Includes teachers indicating 3 or 4 on a four-point scale ranging from 1 "not adequately prepared" to 4 "very well prepared."

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (proportion of teachers feeling at least fairly well-prepared in the 60 or more hours group significantly different than in the 0 hours group, RS3-adjusted chi-square, WesVar 4.2).

When the various topic areas were combined into a single composite score for content preparedness, small but significant differences were found between teachers with no treatment and those with 60 or more hours of LSC professional development in K–8 science, K–8 mathematics, and 6–12 mathematics (effect sizes of 0.24, 0.26, and 0.30 standard deviations respectively). (See Figure 27.) The lack of significance for 6–12 science teachers may be partially explained by the fact that the low number of teachers who were administered the questionnaire reduces the likelihood of finding significant differences.

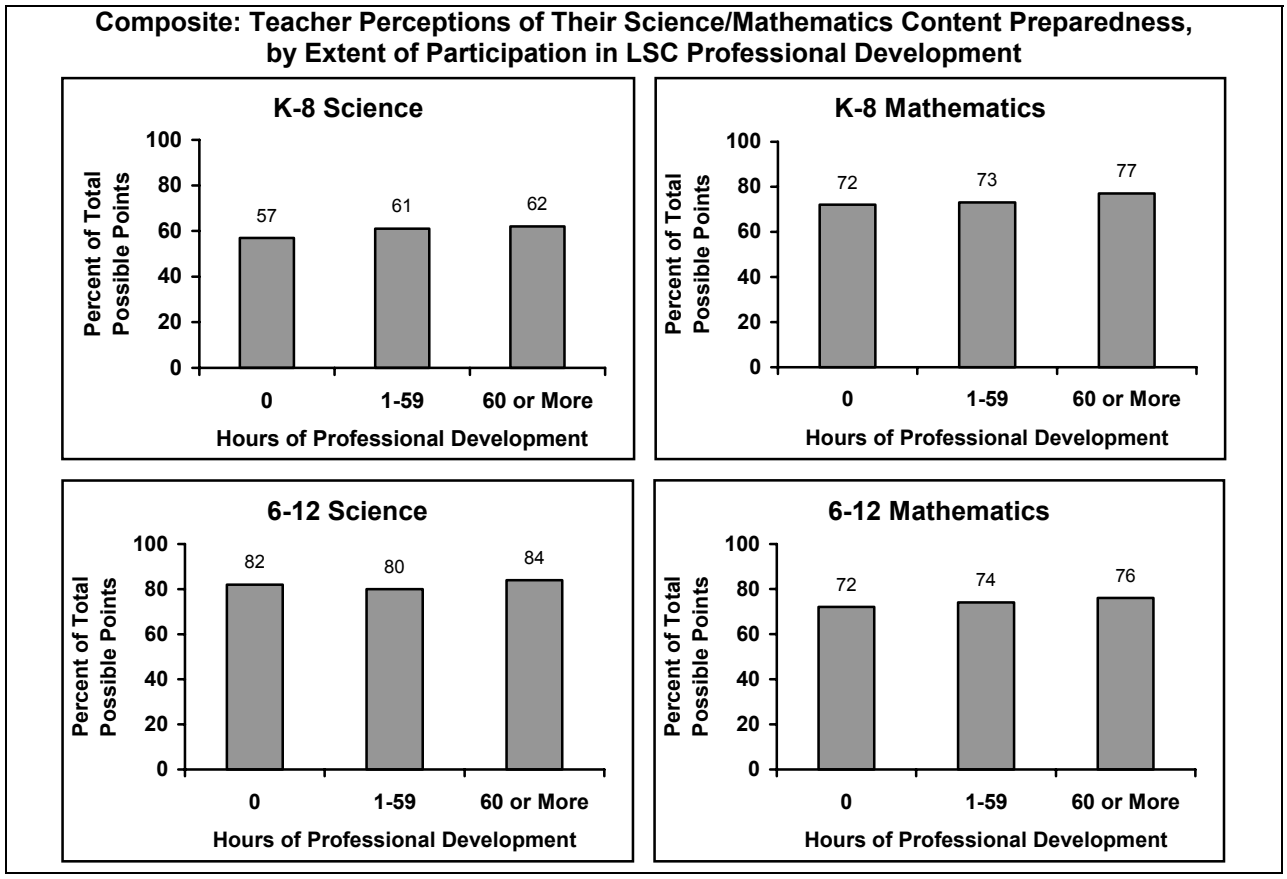

Figure 27

Questionnaire data on other items provide additional support for the impact of the LSC on teacher self-confidence. For example, the larger the number of hours of LSC professional development, the more likely teachers were to indicate that they are well-informed about national mathematics/science standards. (See Figure 28.)

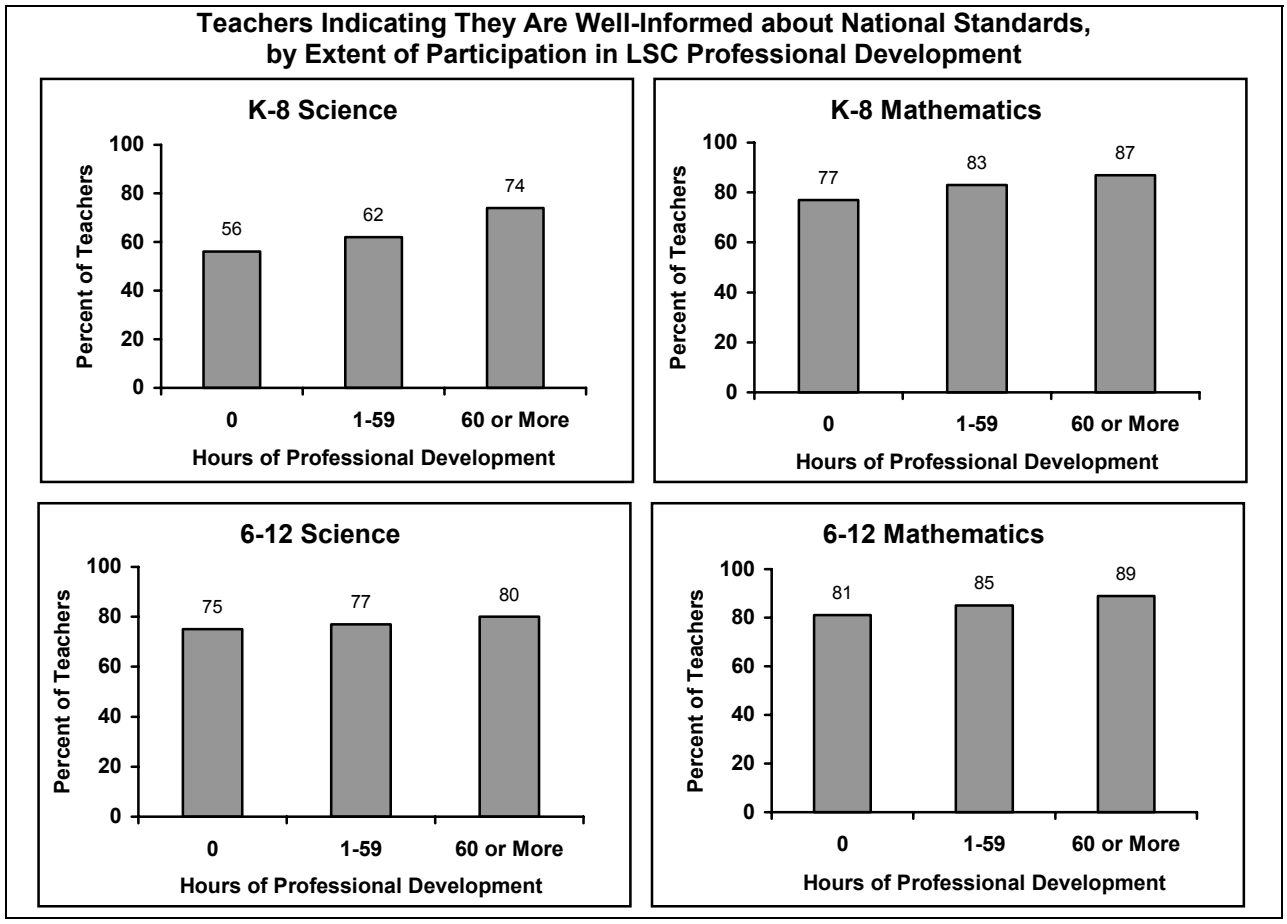

Figure 28

Figure 29 shows the results on a composite of items about teacher preparedness to use a variety of instructional strategies in their mathematics/science instruction, including taking students' prior understanding into account when planning curriculum and instruction, having students work in cooperative learning groups, and using informal questioning to assess student understanding. The seven percentage point difference between untreated and highly-treated K–8 mathematics teachers constitutes a medium effect (0.60 standard deviations). The 3–5 point differences for the other groups constitute small effects of 0.43 standard deviations for K–8 science teachers, 0.23 standard deviations for 6–12 mathematics teachers, and 0.29 standard deviations for 6–12 science teachers.

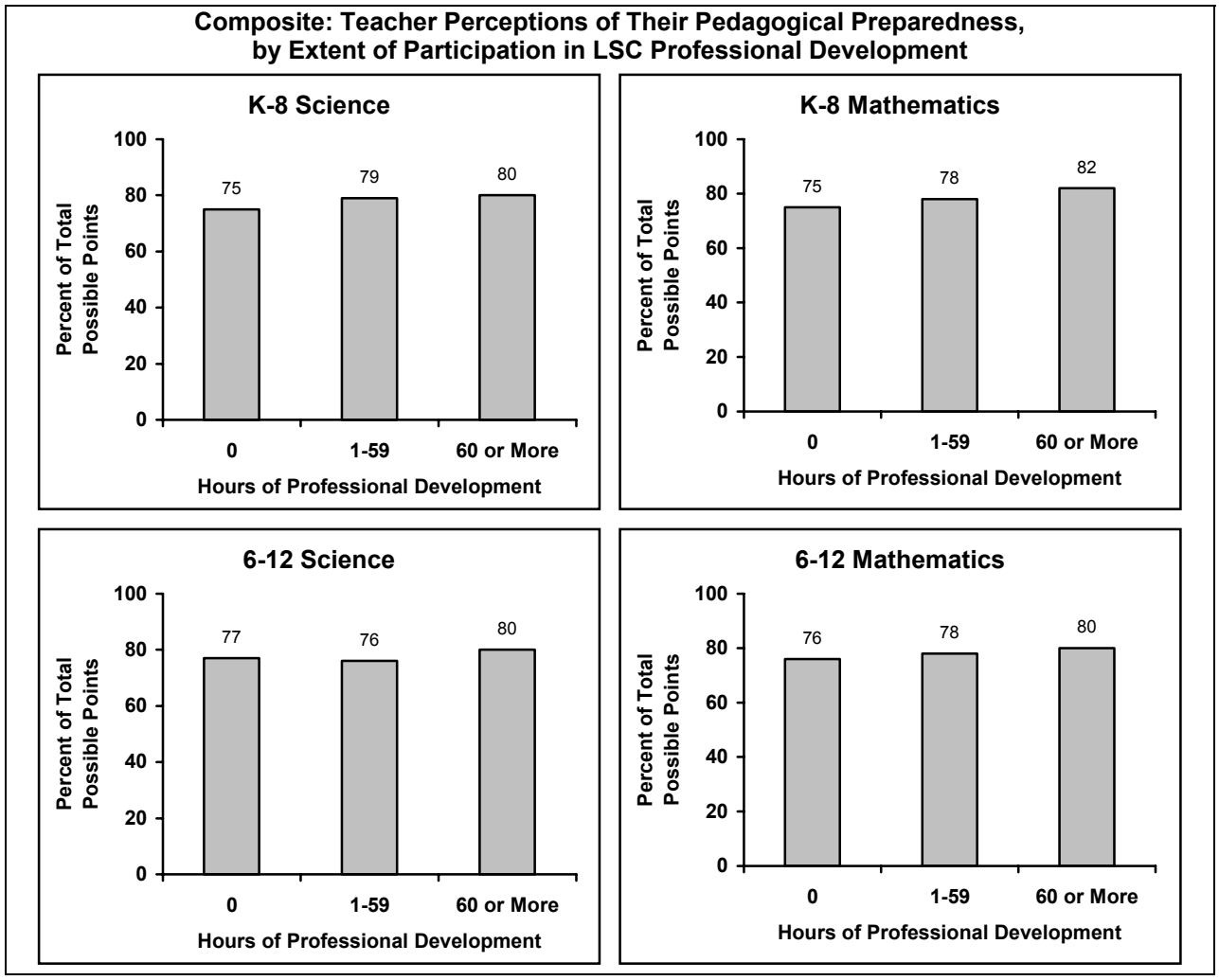

Figure 29

IV. Impact of the LSC on Classroom Practice

A. Introduction

The core evaluation focuses a great deal of attention on the impact of the LSC projects on classroom instruction. Data come from several sources: classroom observations, teacher interviews, and teacher questionnaires. As was the case with impact on teachers, the impact of the LSC on classroom practice is assessed by comparing results for teachers with varying extents of participation in LSC professional development.

B. Time Spent on Elementary Science Instruction

One of the impacts of the LSC has been increased attention to science instruction in the elementary grades. As can be seen in Figure 30, the average number of days per week in which science is taught increases from 2.2 days among untreated teachers to 2.7 days among teachers with 60 or more hours of LSC professional development.

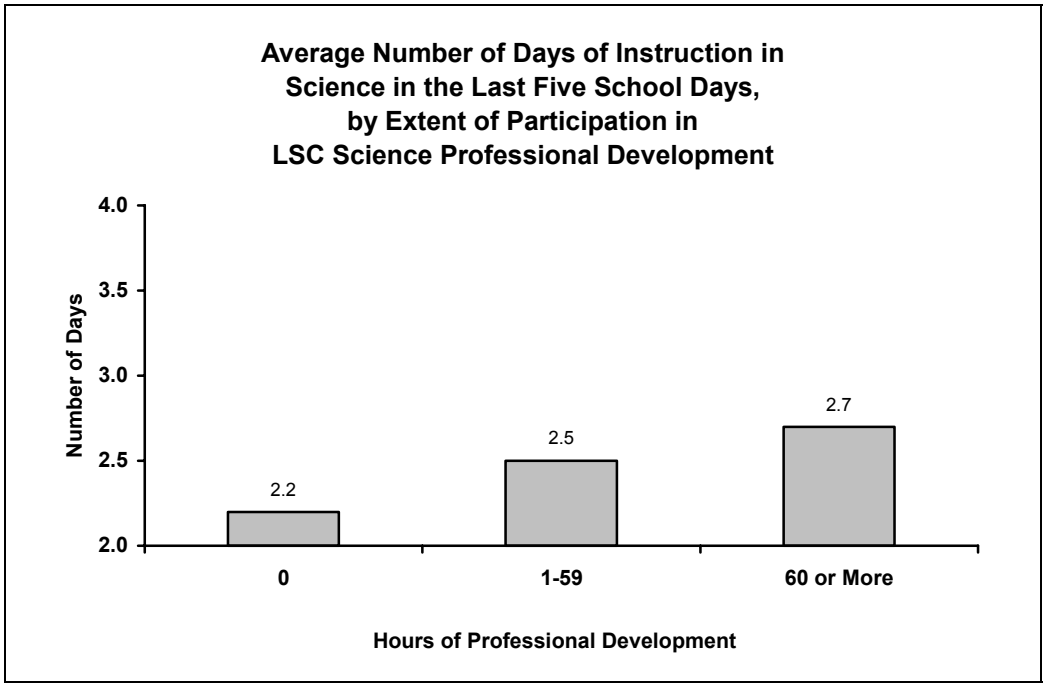

Figure 30

As would be expected, the increased frequency of science instruction results in a greater amount of time devoted to the subject. As can be seen in Figure 31, 23 percent of teachers who had participated in 60 or more hours of LSC science professional development spent 150 or more minutes on science each week, compared to only 12 percent of untreated teachers.

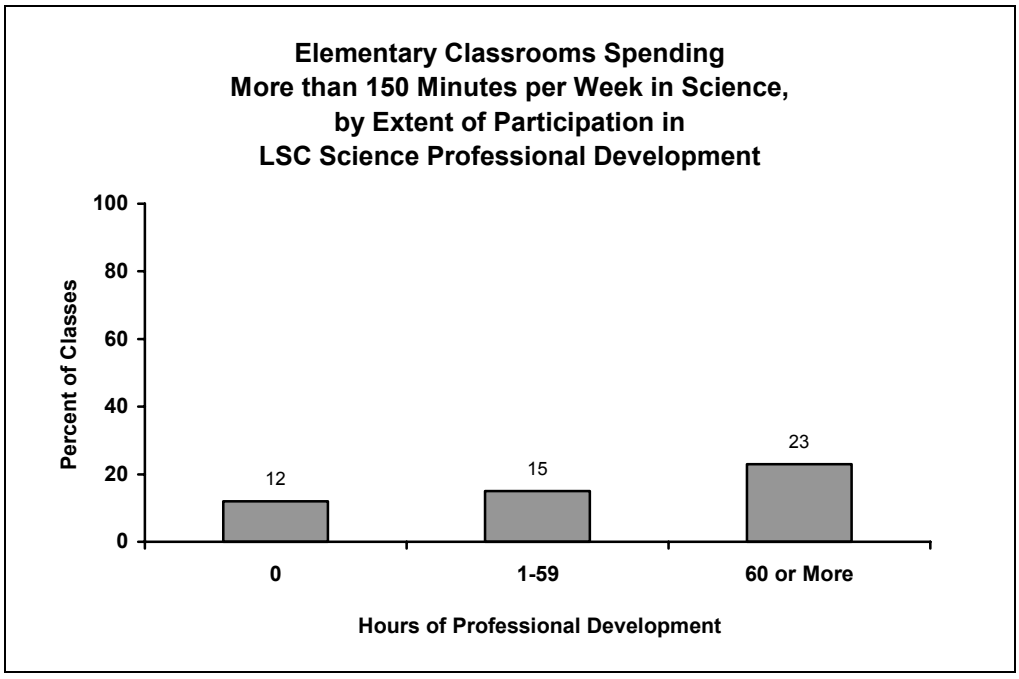

Figure 31

Overall, few elementary science teachers implement six or more science units per year. (See Figure 32.) However, as can be seen in Figure 33, the length of units increases with participation in LSC professional development, with 87 percent of the teachers who have participated most heavily in the LSC report spending four weeks or more on a typical science unit, compared to 78 percent of untreated teachers.

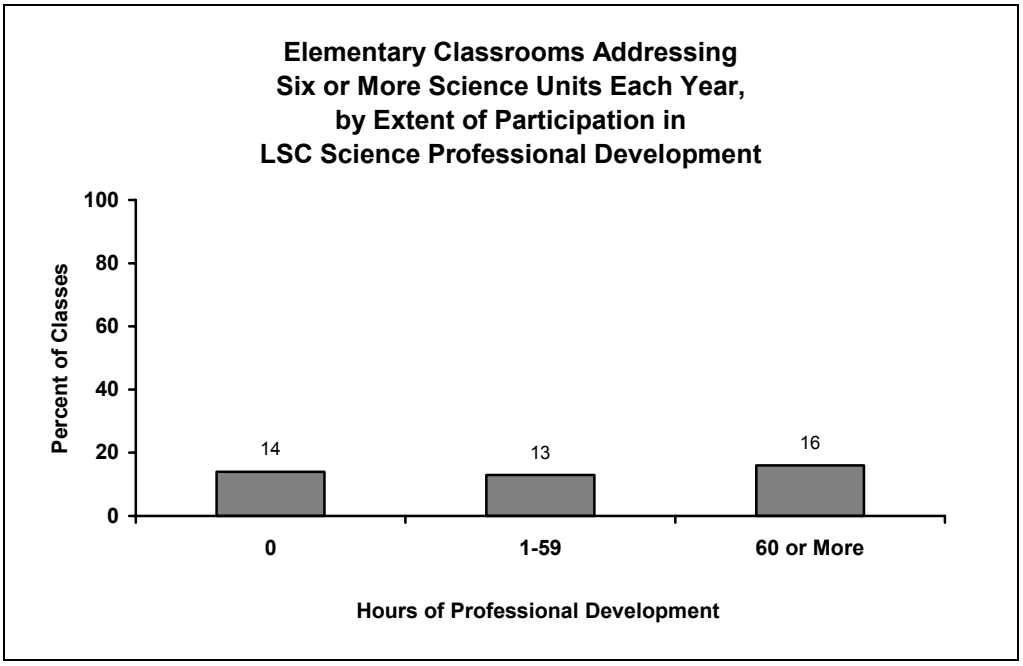

Figure 32

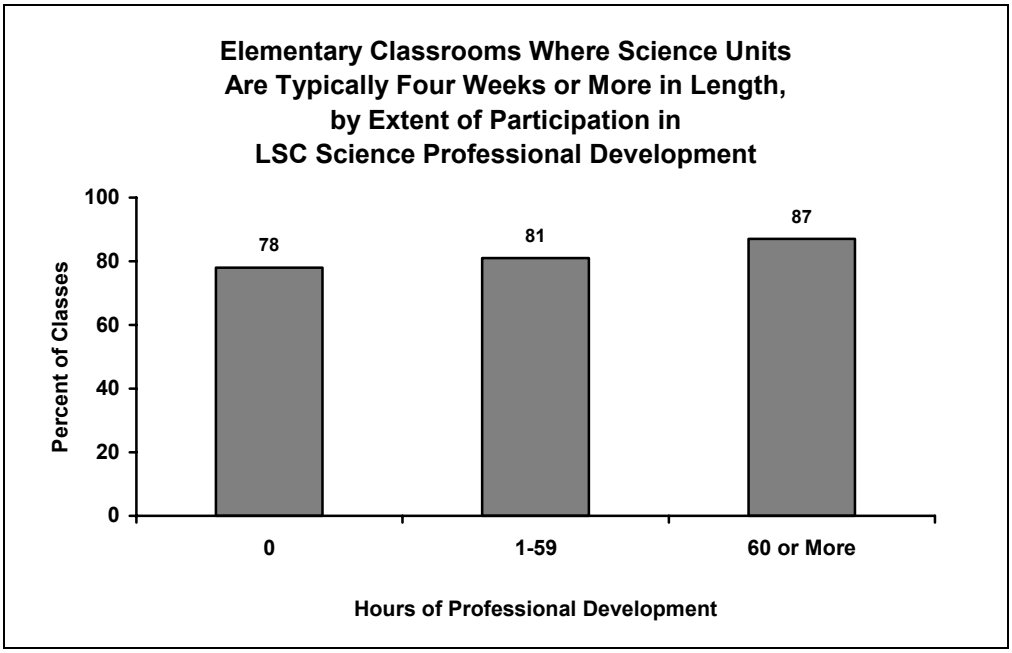

Figure 33

C. Instructional Strategies

One indication of the impact of LSC activities on classroom practice comes from composites created from questionnaire data. The investigative culture composite includes strategies used by teachers to facilitate exploration and investigation by students. It includes such practices as:

- Arranging seating to facilitate student discussion;
- Using open ended questions;
- Requiring students to supply evidence to support their claims; and
- Encouraging students to consider alternative explanations.

There is a significant increase in scores on this composite with increasing participation in LSC activities for 3 of the 4 targeted subject/grade-levels. (See Figure 34.) The seven-point difference between untreated and highly treated teachers in K–8 science, as well as the eight-point difference in K–8 mathematics, represent medium effect sizes (0.60 and 0.52 standard deviations respectively). The five-point difference in 6-12 mathematics represents a small effect size (0.43 standard deviations).

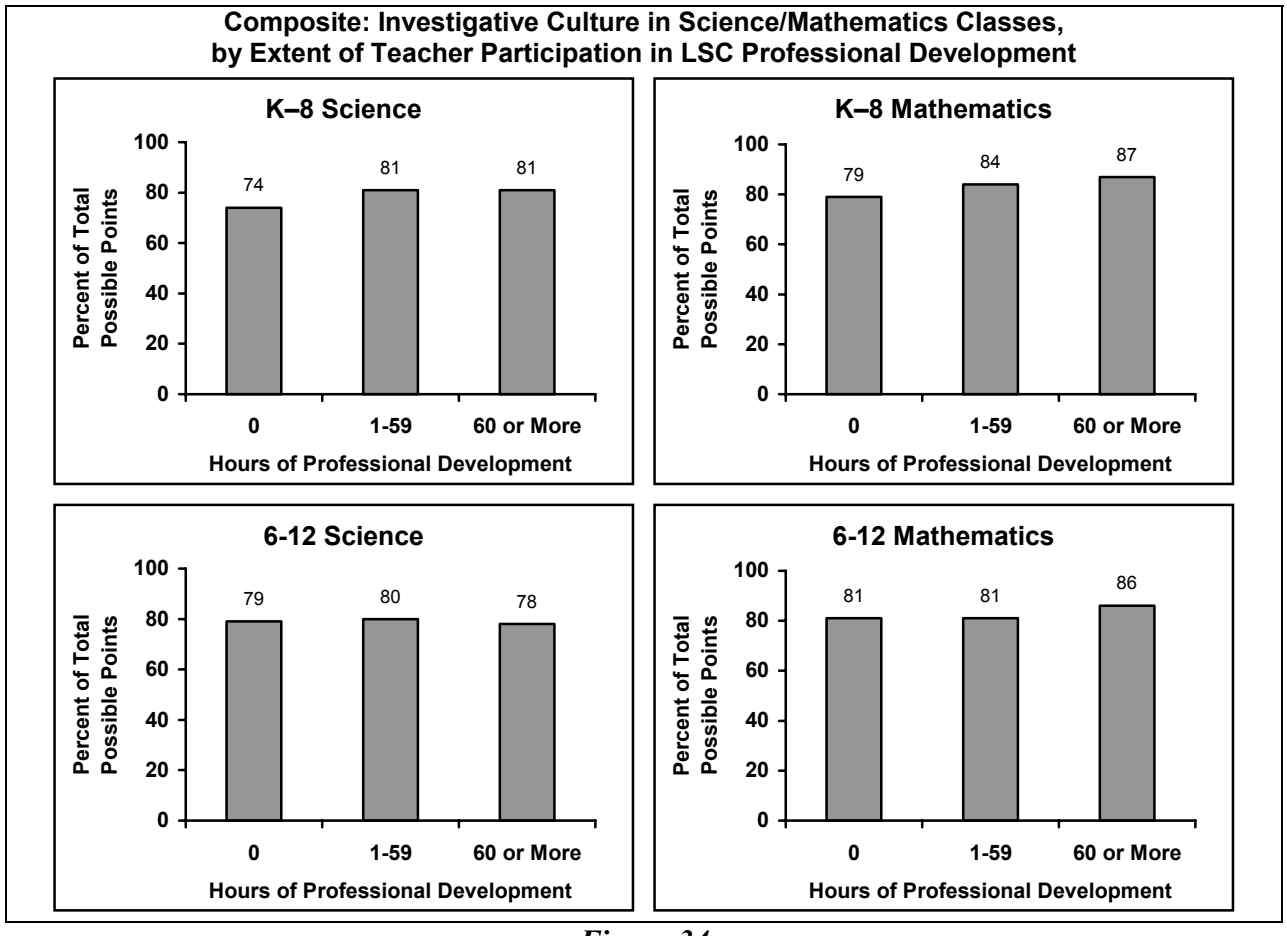

Figure 34

The investigative practices composite is tied to what students actually do in the classroom. It includes such instructional strategies as having students:

- Engage in hands-on mathematics/science activities;
- Work on models or simulations;
- Work on extended investigations; and
- Write reflections in a notebook or journal.

As shown in Figure 35, there is an increase in composite scores for K–8 science and K–8 mathematics teachers with increasing participation in LSC activities. The seven-point difference between untreated and highly-treated teachers in both subjects represents a medium effect size (0.51 standard deviations for each subject).

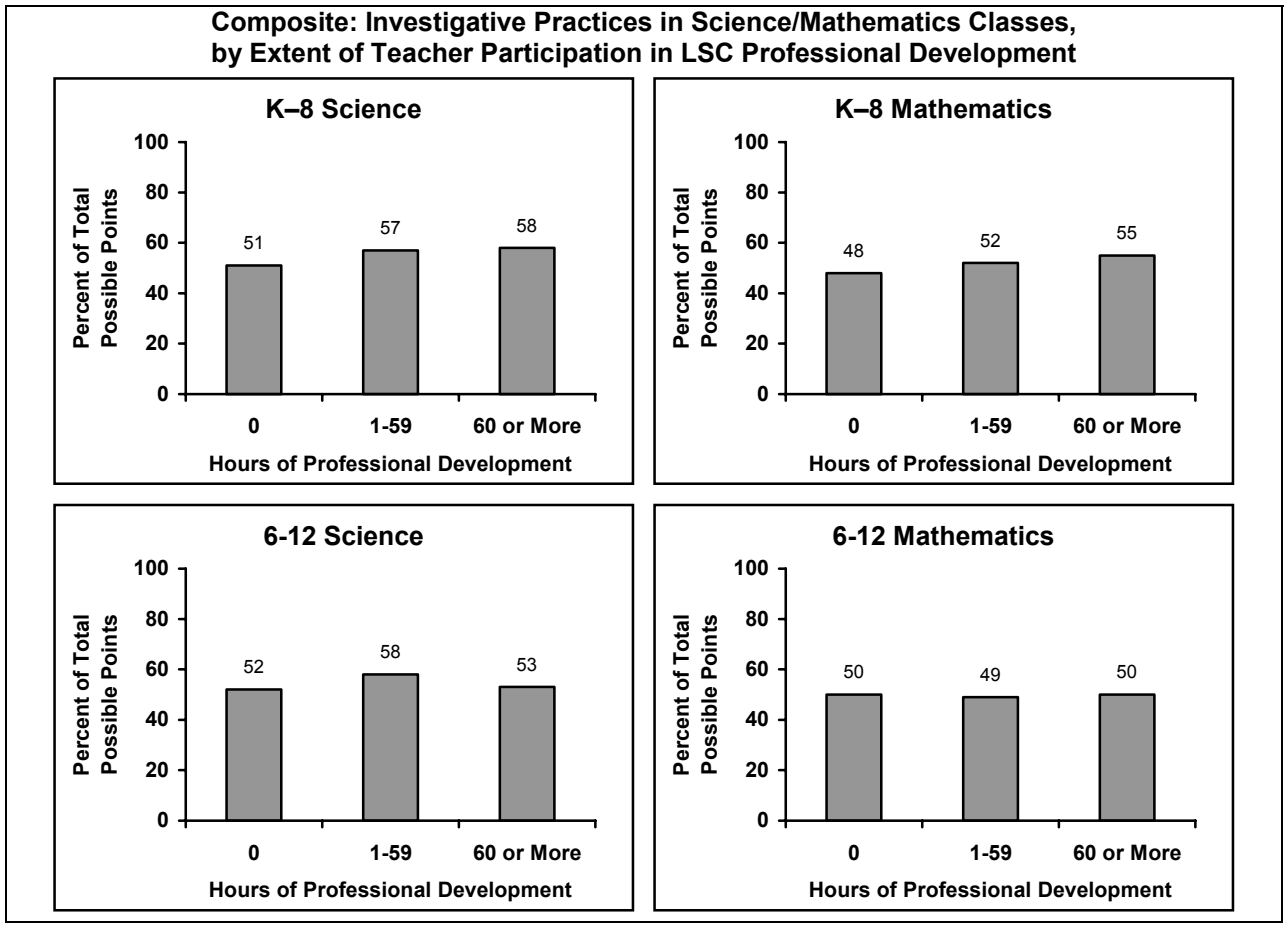

Figure 35

D. Quality of Observed Lessons

Trained observers visited classrooms of teachers who had already participated in LSC professional development and others who had not yet participated and assessed the quality of the lessons using a variety of indicators. (See box.)

Sample Indicators for Classroom Observations

Design

- The design of the lesson incorporated tasks, roles, and interactions consistent with investigative mathematics/science.
- The design of the lesson reflected careful planning and organization.
- The instructional strategies and activities used in this lesson reflected attention to students' experience, preparedness, and/or learning styles.
- The resources available in this lesson contributed to accomplishing the purposes of the instruction.
- The design of the lesson encouraged a collaborative approach to learning.
- Adequate time and structure were provided for "sense-making."
- Adequate time and structure were provided for wrap-up.

Implementation

- The instruction was consistent with the underlying approach of the instructional materials designated for use by the LSC.
- The teacher's classroom management style/strategies enhanced the quality of the lesson.
- The pace of the lesson was appropriate for the developmental levels/needs of the students and the purposes of the lesson.
- The teacher was able to "read" the students' level of understanding and adjust instruction accordingly.
- The teacher's questioning strategies were likely to enhance the development of student conceptual understanding/problem solving (e.g., emphasized higher order questions, appropriately used "wait time," identified prior conceptions and misconceptions).

Mathematics/Science Content

- The mathematics/science content was significant and worthwhile.
- The mathematics/science content was appropriate for the developmental levels of the students in this class.
- Students were intellectually engaged with important ideas relevant to the focus of the lesson.
- Teacher-provided content information was accurate.
- Appropriate connections were made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts.

Classroom Culture

- Active participation of all was encouraged and valued.
- There was a climate of respect for students' ideas, questions, and contributions.
- Interactions reflected collegial working relationships among students (e.g., students worked together, talked with each other about the lesson).
- The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.

Observers then rated the quality of each lesson's design and implementation, the science/ mathematics content, and the classroom culture. In addition, each lesson was given an overall capsule rating. As can be seen in Figure 36, lessons of treated teachers (those who had participated in 20 or more hours of LSC professional development) were more likely to receive high design, implementation, content, classroom culture, and capsule ratings than those of teachers who had not yet participated (effect sizes of 0.48, 0.41, 0.46, 0.49, and 0.34 respectively).[12]

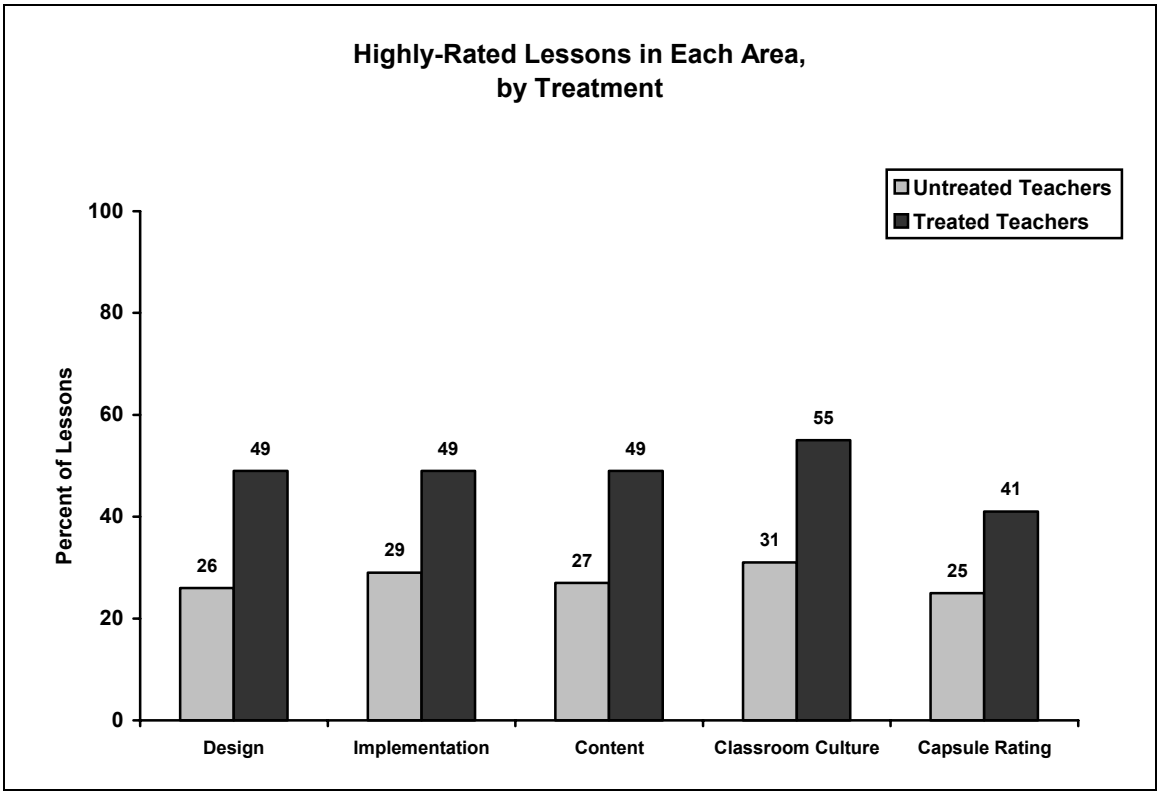

Figure 36

[12] While questionnaire results were typically presented for three levels of participation in LSC professional development (0, 1–59, and 60 or more hours), the considerably smaller number of classroom observations prevented that extent of disaggregation.

Classroom observers also considered the potential for student impact as they observed lessons. Areas of likely student impact are compared for treated and untreated teachers in Figure 37. Significant differences were found for the likelihood of positive impact on students' capacity to carry out their own inquiries, self-confidence in mathematics/science, and interest in and/or appreciation for mathematics/science, in each case favoring lessons taught by teachers who had participated in 20 or more hours of LSC professional development.

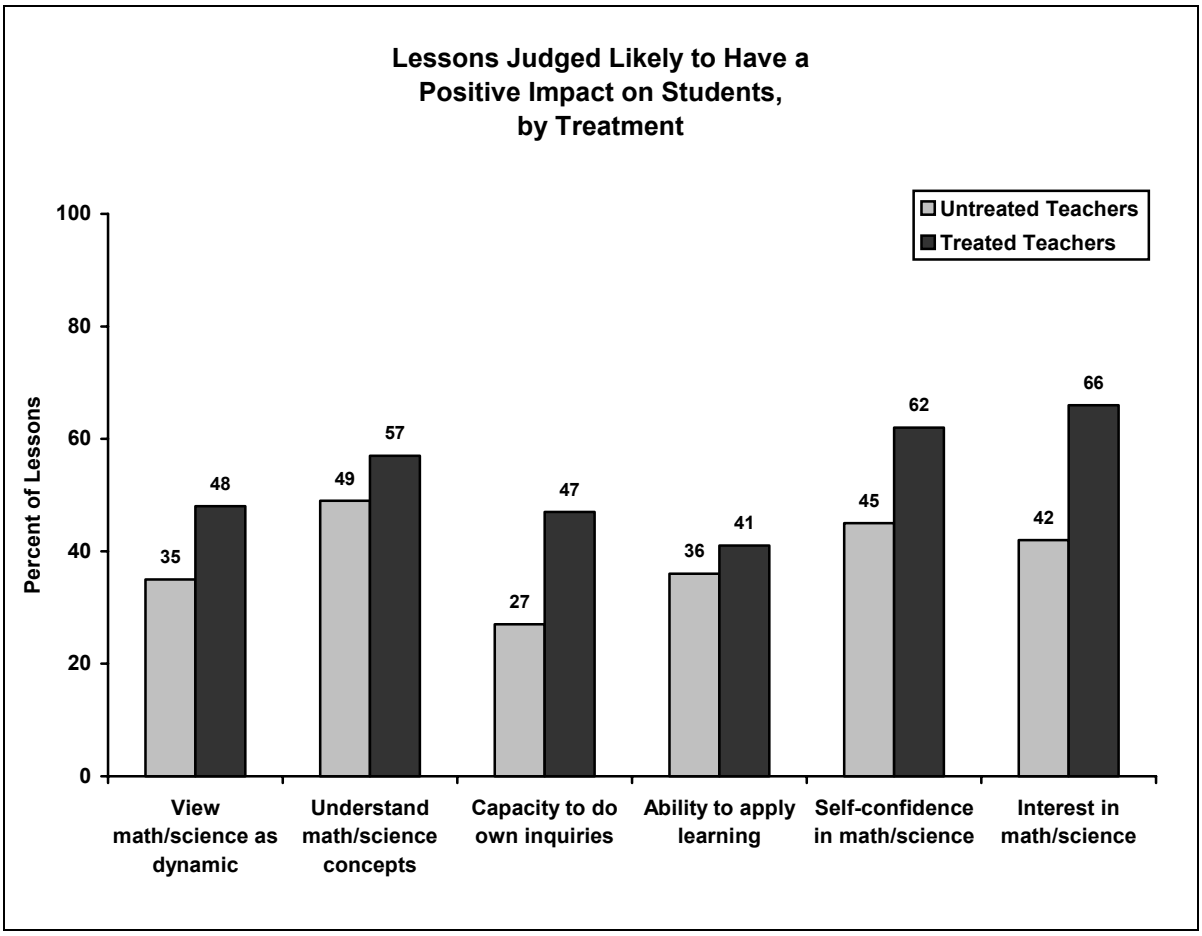

Figure 37

Since a specific goal of the LSC program is to increase the use of exemplary instructional materials, classroom observers were asked to note whether or not these materials were being used and to comment on the quality of their use. As can be seen in Figure 38, 58 percent of the lessons taught by treated teachers were using the designated instructional materials when observed, compared to 41 percent for untreated teachers.

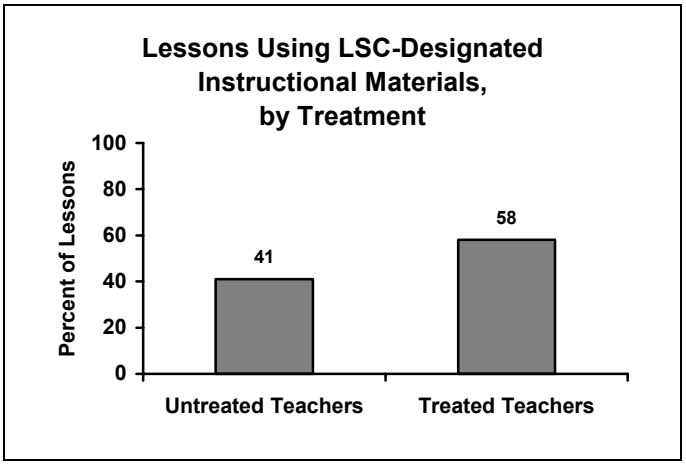

Figure 38

It appears that the combination of LSC-designated materials and LSC professional development is having a positive impact on the quality of classroom instruction. Only 17 percent of lessons taught by teachers who had not participated in LSC professional development and were not using the designated materials received high ratings. Lessons taught by teachers who had participated in at least 20 hours of LSC professional development and were using the designated materials were more than twice as likely to receive high ratings. (See Figure 39.)

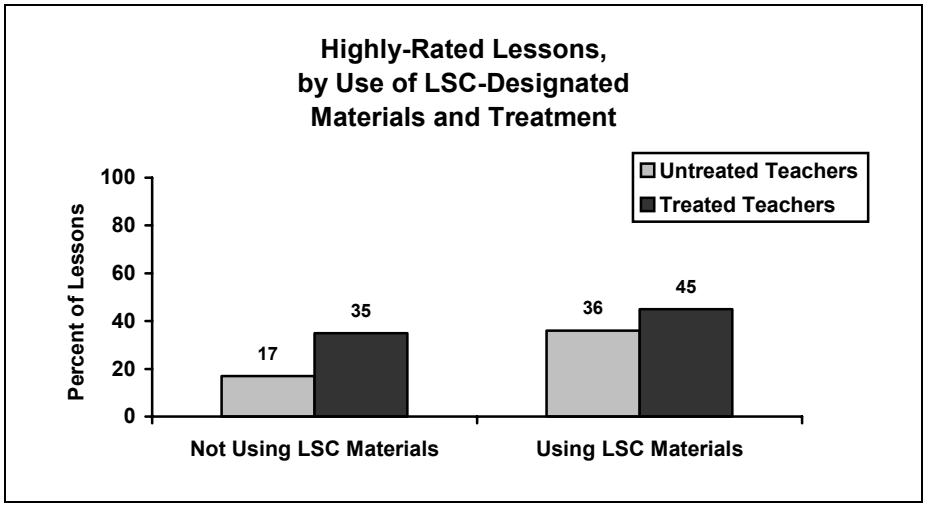

Figure 39

Other findings from the core evaluation also reinforce the LSC program's emphasis on having teachers implement the designated instructional materials as designed by their developers. Figure 40 shows that the more closely the lesson adhered to the instructions provided in the teacher's manual, the more likely it was to be rated effective. Fifty-one percent of the lessons that adhered closely to the materials were given high ratings (capsule ratings of 4 or 5) compared to only 34 percent of the lessons with low adherence.

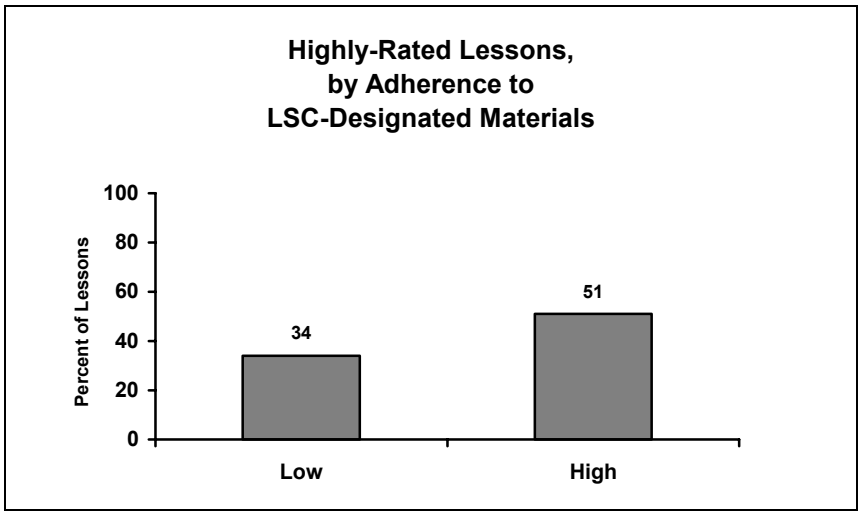

Figure 40

V. Conclusions

Results from the 2002–03 Local Systemic Change core evaluation continue to show areas of both strength and weakness in the design and implementation of the professional development and the impact of those interventions on teachers and their teaching.

Evaluators were asked to observe a representative sample of professional development sessions and rate each in relation to its particular purposes. Sessions were most likely to receive high ratings for providing a climate of respect, encouraging active participation, and a collaborative approach to learning, and addressing appropriate mathematics/science content. The most salient weaknesses in sessions for classroom teachers were in questioning participants in ways likely to enhance their conceptual understanding, in providing adequate time and structure for wrap-up, and in the appropriateness of "sense-making" about classroom practice.

Interestingly, the majority of the observed sessions were facilitated by district personnel, most often full- or part-time teacher leaders. Fewer than 1 in 5 sessions included scientists or mathematicians as professional development providers, and only 2 in 5 had a major focus on increasing teacher content knowledge, raising the concern that the LSC professional development does not emphasize adequately the need to deepen teacher disciplinary content knowledge. Similarly, just over one-third of the observed sessions included a focus on helping teachers understand student thinking/learning about mathematics or science content, an area that is increasingly being identified as important in teacher development.

While only 39 percent of the teachers rated the LSC professional development excellent or very good, the more hours of participation in LSC professional development, the higher the ratings of quality. In interviews, teachers indicated that having the opportunity to deepen their content and pedagogical knowledge, receiving materials needed for instruction, the high quality of LSC professional development, and the opportunities to collaborate with other teachers were particularly helpful aspects of the LSC. Concerns focused on the amount of time required to attend professional development; in some cases, the quality of the professional development; and especially, problems teachers experience in implementing the instructional materials in their classrooms.

Questionnaire data collected from targeted teachers suggest that LSC professional development has had a significant impact on teachers' perceptions of their pedagogical preparedness. In addition, participants were becoming more confident in their knowledge of mathematics and science content, and more likely to use standards-based instructional strategies, particularly in grades K–8

K–8 science, K–8 mathematics, and 6–12 mathematics participants reported making greater use of strategies that facilitate exploration and investigation by students than did teachers who had not participated in LSC professional development, such as using open ended questions and requiring students to supply evidence to support their claims. Both K–8 mathematics and science participants were also more likely than other teachers to use reform-oriented teaching

practices such as having students engage in hands-on activities, work on extended investigations, and write reflections in notebooks or journals.

Classroom observations show that teachers who participated in LSC professional development were more likely to be using the designated instructional materials, and that the quality of the lessons taught improved with participation in LSC activities. Furthermore, lessons taught by teachers who had participated in at least 20 hours of LSC professional development and were using the designated materials were more likely to receive high ratings for their lessons, lending support to the program's focus on professional development aimed at implementing exemplary instructional materials.

Appendix Tables

Summary of the Impact of LSC Professional Development on Teacher Perceptions of Their Preparedness and on Their Teaching

K–8 Science

Questionnaire Composite	Mean: 0 Hours (N = 161)	Mean: 60 or More Hours (N = 580)	Pooled Standard Deviation	Effect Size (d)
Attitudes Toward Teaching	85.70	86.99	9.45	0.14
Pedagogical Preparedness	74.58	80.30	13.31	0.43**
Content Preparedness	57.48	61.51	16.83	0.24***
Investigative Culture	73.99	81.24	13.81	0.52***
Investigative Practices	50.94	58.22	14.24	0.51***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (composite score for the 60 or more hours group significantly greater than for the 0 hours group, 1-tailed independent samples t-test – WesVar 4.2)

6–12 Science

Questionnaire Composite	Mean: 0 Hours (N = 92)	Mean: 60 or More Hours (N = 151)	Pooled Standard Deviation	Effect Size (d)
Attitudes Toward Teaching	85.93	82.99	10.15	-0.29
Pedagogical Preparedness	76.08	79.74	12.68	0.29*
Content Preparedness	82.38	84.22	14.68	0.13
Investigative Culture	78.79	78.46	11.91	-0.03
Investigative Practices	52.07	53.37	13.19	0.10

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (composite score for the 60 or more hours group significantly greater than for the 0 hours group, 1-tailed independent samples t-test – WesVar 4.2)

K–8 Mathematics

Questionnaire Composite	Mean: 0 Hours (N = 380)	Mean: 60 or More Hours (N = 1197)	Pooled Standard Deviation	Effect Size (d)
Attitudes Toward Teaching	85.58	88.75	9.61	0.33***
Pedagogical Preparedness	74.52	82.41	13.14	0.60***
Content Preparedness	72.38	76.54	16.30	0.26***
Investigative Culture	79.16	86.77	12.60	0.60***
Investigative Practices	47.83	55.39	14.68	0.51***
Use of Calculators and Computers	47.23	53.59	20.19	0.31***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (composite score for the 60 or more hours group significantly greater than for the 0 hours group, 1-tailed independent samples t-test – WesVar 4.2)

6–12 Mathematics

Questionnaire Composite	Mean: 0 Hours (N = 231)	Mean: 60 or More Hours (N = 475)	Pooled Standard Deviation	Effect Size (d)
Attitudes Toward Teaching	83.52	82.91	10.69	-0.06
Pedagogical Preparedness	77.32	80.15	12.12	0.23***
Content Preparedness	71.71	76.07	14.70	0.30**
Investigative Culture	81.31	86.36	11.72	0.43***
Investigative Practices	50.21	49.68	14.20	-0.04
Use of Calculators and Computers	67.93	72.95	19.55	0.26***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; (composite score for the 60 or more hours group significantly greater than for the 0 hours group, 1-tailed independent samples t-test – WesVar 4.2)

Report Available on the Web

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