Chapter Six
Current Status of Teachers' Beliefs and Practices

During the core evaluation process, considerable data were collected about mathematics and science instruction in LSC districts. This chapter presents data on the current status of teacher beliefs and practices, drawn from teacher questionnaires, teacher interviews, and classroom observations.

Description of Targeted Teachers' Beliefs and Practices

The cross-site data analyzed for this report support many of the findings of the previous year. As can be seen in Table 13, teachers generally report positive attitudes toward teaching mathematics and science, and they feel supported by colleagues to try out new ideas. Although they frequently share materials and ideas with their colleagues, there is little time set aside during the school week to work with peers. These findings are consistent across subjects and grade levels.

Table 13
Teacher Opinions about Science/Mathematics Teaching

	Percent of Teachers Agreeing			
	All Teachers	**K–8 Science**	**K–8 Mathematics**	**7–12 Mathematics**
I enjoy teaching mathematics/science.	88	86	92	96
I feel supported by colleagues to try out new ideas in teaching mathematics/science.	81	80	81	85
Teachers in this school regularly share ideas and materials related to mathematics/science.	63	62	63	68
Teachers in this school have a shared vision of effective mathematics/science instruction.	57	55	59	61
Teachers in this school are well-supplied with materials for investigative mathematics/science instruction.	53	50	61	45
I have time during the regular school week to work with my peers on mathematics/science curriculum and instruction.	16	14	19	18

Familiarity with National Standards

Teachers were asked about their familiarity with current national standards for mathematics/science education. Figure 23 shows the percentage of teachers in each group indicating that they are "well informed" about the National Science Education Standards/National Council of Teachers of Mathematics (NCTM) Standards. Note that secondary mathematics teachers were most likely, and elementary science teachers least likely, to report being familiar with national standards.

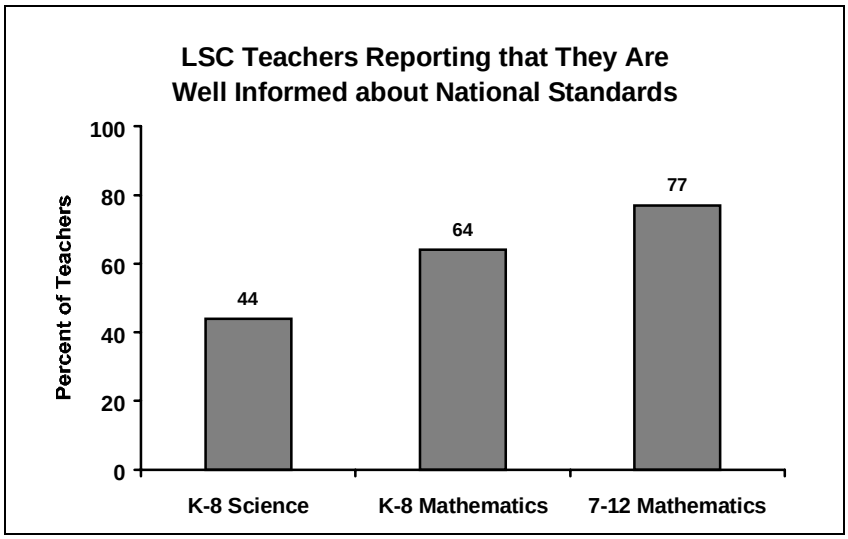


Figure 23

Beliefs about Effective Instruction

While they may not be familiar with the standards documents *per se*, most LSC elementary teachers, nevertheless, report attitudes and beliefs that are in fairly close alignment with standards-based instruction. (See Table 14.) For example, 90 percent of targeted elementary science teachers and 80 percent of targeted elementary mathematics teachers believe it is very important to have students participate in hands-on activities. Large numbers of these elementary teachers also believe it is very important to provide concrete experience before introducing abstract concepts and to engage students in inquiry-oriented activities. Secondary mathematics teachers targeted by the LSC projects are less likely to consider these strategies to be of great importance.

Table 14
Teachers Rating Each Factor Very Important for Effective Instruction

	Percent of Teachers			
	All Teachers	**K–8 Science**	**K–8 Mathematics**	**7–12 Mathematics**
Have students participate in appropriate hands-on activities	84	90	80	52
Provide concrete experience before abstract concepts	79	80	82	57
Develop student' conceptual understanding of mathematics/science	77	74	84	77
Take students' prior understanding into account when planning curriculum and instruction	73	71	79	66
Make connections between mathematics/science and other disciplines	69	71	67	57
Engage students in inquiry-oriented activities	67	71	62	49
Engage students in application of mathematics/science in a variety of contexts	64	59	74	63
Use informal questioning to assess student understanding	56	57	57	44
Practice computational skills and algorithms	54	—	58	39
Have students work in cooperative learning groups	53	57	50	32

It is also interesting to note that support for ability grouping is stronger among mathematics teachers than science teachers. (See Figure 24.)

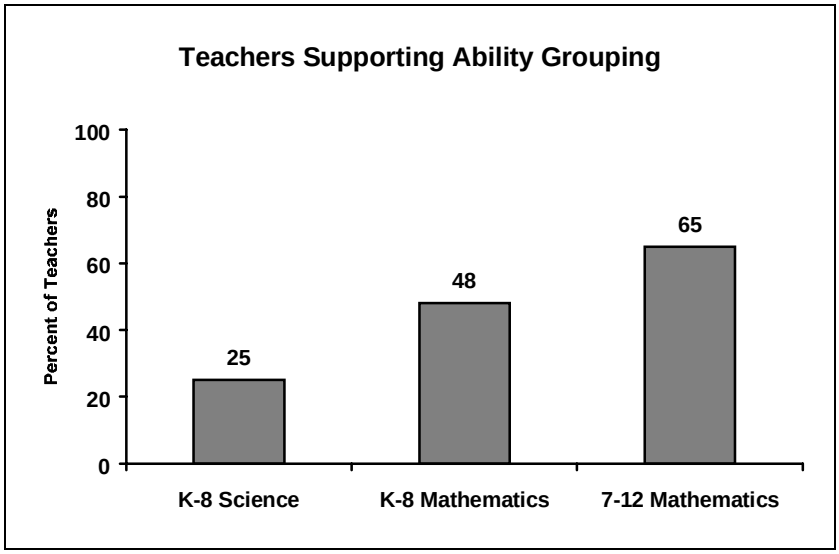


Figure 24

Feelings of Preparedness

Inclination toward standards-based instructional strategies is an important first step, but in order to see meaningful change in classroom practice, teachers need also to be prepared to use these strategies in their classrooms. Table 15 shows the percentage of teachers in each group reporting that they feel at least fairly well prepared to implement each of a number of instructional strategies in their classes.

Among the highlights:

- Elementary teachers are more likely than secondary teachers to feel prepared to use a number of reform-oriented strategies, including hands-on activities and cooperative learning;

- Higher proportions of elementary and secondary mathematics teachers than K–8 science teachers feel prepared to develop students' conceptual understanding of their subjects; and

- In each subject, relatively few teachers feel prepared to use either computers or portfolios.

Table 15
Teachers Considering Themselves at Least Fairly Well-Prepared to Implement Each Instructional Strategy

	Percent of Teachers			
	All Teachers	**K–8 Science**	**K–8 Mathematics**	**7–12 Mathematics**
Practice computational skills and algorithms	90	—	89	93
Have students work in cooperative learning groups	83	83	84	74
Have students participate in appropriate hands-on activities	82	81	87	68
Use informal questioning to assess student understanding	81	81	82	76
Take students' prior understanding into account when planning curriculum and instruction	79	75	87	78
Make connections between mathematics/science and other disciplines	76	75	81	69
Develop students' conceptual understanding of mathematics/science	75	69	86	88
Provide concrete experience before abstract concepts	74	69	85	75
Use calculators	74	—	71	87
Engage students in inquiry-oriented activities	68	67	72	62
Engage students in applications of mathematics/science in a variety of contexts	64	58	77	68
Use performance-based assessment	63	57	76	65
Use portfolios	51	50	56	40
Use computers	44	39	51	51

Differences are found in feelings of preparedness to teach content, as well. At the elementary level, where teachers typically are responsible for teaching both mathematics and science, teachers feel better prepared to teach mathematics content than science content. As can be seen in Table 16, 92 percent of LSC elementary teachers report feeling at least fairly well prepared to teach mathematics, compared to only 69 percent feeling that level of preparedness to teach science.

Table 16
K–8 Teachers Feeling Well-Prepared to Teach Each Subject

	Percent of Teachers		
	All Teachers	**Science**	**Mathematics**
Reading/Language Arts	94	95	92
Mathematics	92	92	91
Social Studies	81	82	78
Science	69	72	64

Within these content areas, teachers feel better prepared to teach some topics than others. In mathematics, the great majority of both K–8 and 7–12 teachers feel at least fairly well prepared to teach computation, patterns and relationships, numeration and number theory, measurement, and estimation. Somewhat fewer, but still more than three-fourths of the teachers in each group, feel well prepared to teach geometry/spatial sense, and data collection and analysis at their assigned grade levels. In contrast, while 93 percent of grades 7–12 mathematics teachers report feeling at least fairly well prepared to teach pre-algebra and 86 percent to teach algebra, relatively few K–8 mathematics teachers feel prepared to do so. (See Table 17.)

Table 17
Mathematics Teachers Feeling Well-Prepared to Teach Each Topic

	Percent of Teachers	
	K–8 Mathematics	**7–12 Mathematics**
Computation	97	97
Patterns and relationships	91	90
Numeration and number theory	91	90
Measurement	90	95
Estimation	89	95
Geometry and spatial sense	84	85
Data collection and analysis	79	79
Probability	65	76
Pre-Algebra	60	93
Technology in support of mathematics	57	58
Algebra	47	86
Functions and pre-calculus concepts	—	62
Statistics	—	50
Topics from discrete mathematics	—	35
Calculus	—	29
Mathematics structures	—	26

The situation is quite different in K–8 science, where none of the listed topics comes close to the "90 percent prepared" levels seen in mathematics. Teachers most often report feeling at least fairly well prepared to teach topics from the biological sciences, such as the human body (69 percent) and ecology (63 percent). Far fewer teachers report feeling prepared to teach topics from the earth and physical sciences. (See Table 18.)

Table 18
Science Teachers Feeling Well-Prepared to Teach Each Topic

	Percent of Teachers
The human body	69
Ecology	63
Rocks and soils	50
Sound	46
Astronomy	43
Forces and motion	41
Processes of change over time	39
Mixtures and solutions	39
Machines	39
Electricity	38
Engineering and design principles	22

Teachers' Perceptions of Their Instruction

Teacher questionnaire data, typically from 250 or so responding teachers per project, were supplemented by data from interviews with about 10 teachers in each Cohort 1 and Cohort 2 project. As part of this interview, teachers described their attitudes and classroom practice before the LSC. Evaluators reported a high degree of prior alignment in teacher beliefs about mathematics/science teaching, with roughly half of teachers describing prior attitudes quite consistent with the LSC vision. About one-third of the interviewed teachers described confidence in their ability to teach in the fashion advocated by the LSC, use of aligned curriculum, and aligned instruction prior to the LSC. In contrast, only about 1 in 10 described prior alignment of assessment practices. These results suggest that the LSC projects had a good base upon which to build, with quite a few teachers favorably disposed toward reform.

It is interesting to note the difference in baseline belief alignment reported by teachers in their questionnaires compared to the analyses given based on teacher interviews. The interviewers' summary of alignment of beliefs prior to LSC involvement appears quite a bit lower than that from the questionnaire. This may mean that teachers have a different interpretation of what standards based teaching implies than that of the interviewers. They may be familiar with the rhetoric of reform and so can identify the "correct" answer on the survey. But when asked to go beyond this reform language and describe their beliefs in more reflective terms, discussion reveals a lower level of alignment.

Frequency of Subject Area Instruction

Elementary teachers reported on the number of the last five school days they had taught each of several subjects. Due to the emphasis on reading and mathematics in the elementary curriculum, and perhaps also due in part to teachers' feelings of preparedness, science is taught less frequently than either reading or mathematics. As can be seen in Figure 25, while mathematics was taught on an average of 4.6 of the last five school days, science was taught on an average of 2.8 days.

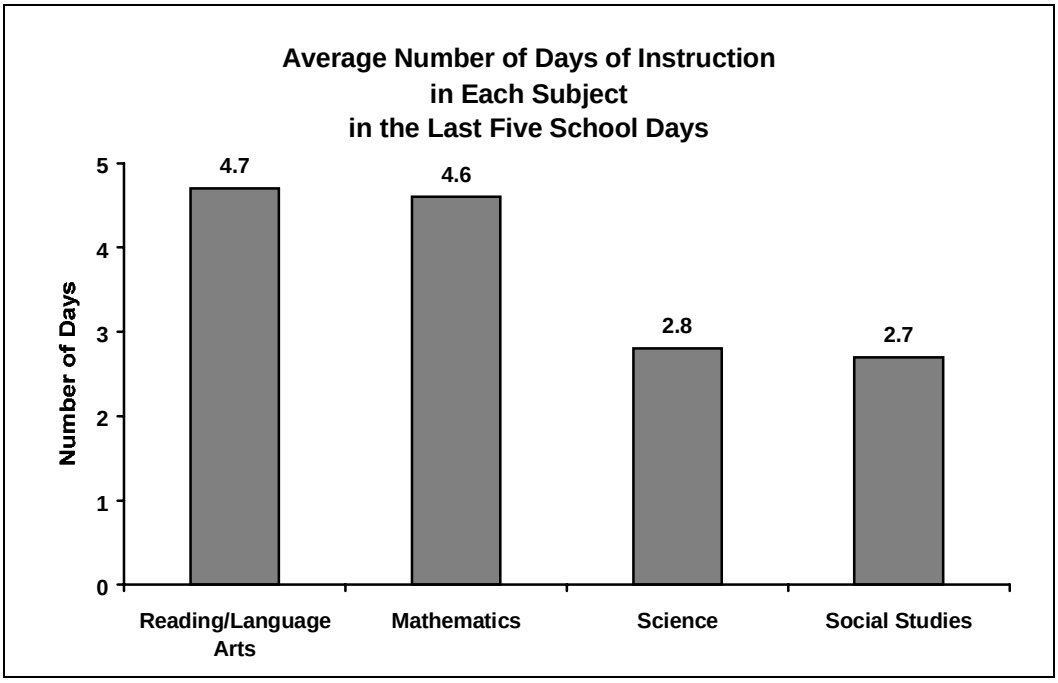


Figure 25

Observers' Descriptions of Classroom Practice

During the spring of 1997, trained observers in each project were to observe 10 randomly selected classrooms. For Cohorts 1 and 2, the teachers to be observed had already participated in at least 20 hours of professional development provided by the project. These are important data because, unlike the questionnaire and interview data, they are not self-report.

A total of 519 classes were observed, including 292 science classrooms; 198 K–8 mathematics classrooms; and 29 7–12 mathematics classrooms. These observations provided information on student demographics, the physical environment, purposes and disciplinary content of the lessons, class activities, and the quality of the lesson in relation to the LSC vision.

Observers noted that classes were relatively small, with most K–8 classes having 25 students or less. The secondary mathematics classes were even smaller, with 70 percent of the classes observed having 20 or fewer students. In terms of race/ethnicity, there is a bi-modal distribution, with about a third of the classes having fewer than 25 percent non-white students, and another third having more than 75 percent non-white students. (See Figure 26.)

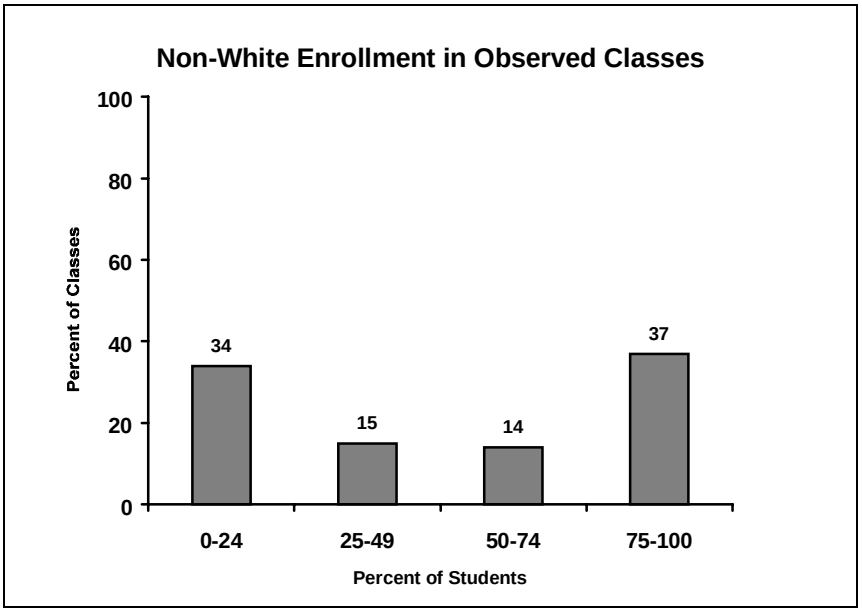
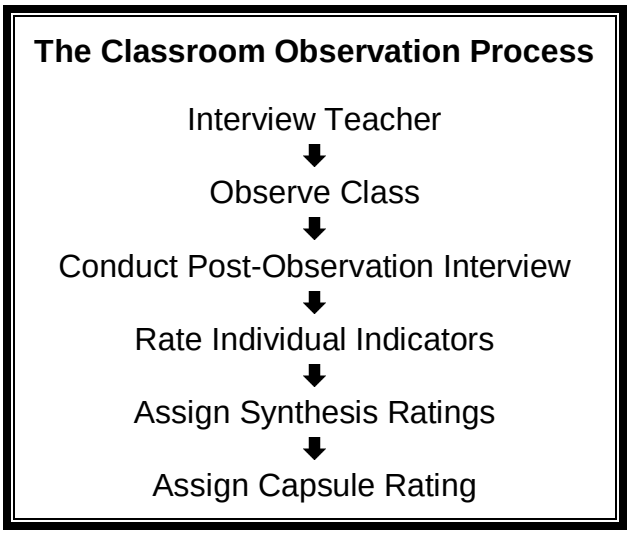


Figure 26

The classroom observation process is summarized in the following chart. Discussion with the teacher occurred both before and following the lesson. Observers then scored their observations on each of a series of individual indicators in the areas of design, implementation, content, and culture/equity. Each area was given a synthesis rating, and a final capsule rating was assigned to the entire lesson.



Purposes of Mathematics and science Lessons

The observer talked with the teacher before and after observing each class to find out about both the intended purpose of the lesson and whether these purposes shifted during the lesson for any reason. As can be seen in Figure 27, roughly half of the K–8 mathematics and science teachers, but only 23 percent of the 7–12 mathematics teachers, reported a major focus on developing conceptual understanding.

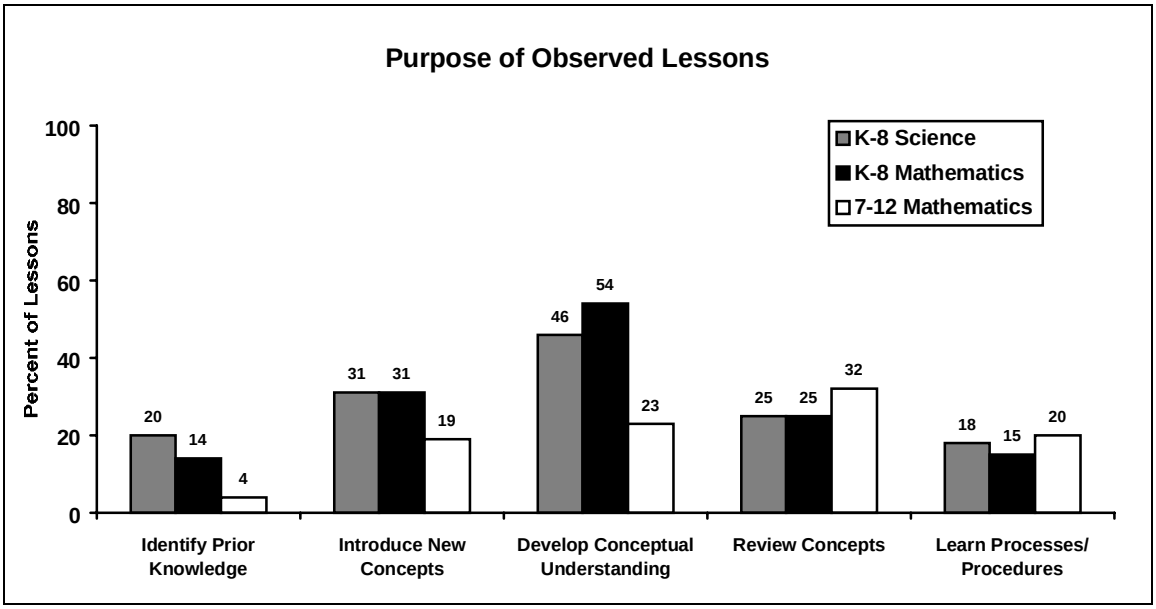


Figure 27

Use of Instructional Materials

Most of the LSC programs are designed around the implementation of a specific set of mathematics or science instructional materials. Therefore, it is appropriate to consider how these recommended instructional materials are being used in the classrooms of the participating teachers.

In observations of classroom practice, the status of use of instructional materials ran the gamut from "traditional" textbooks and worksheets to reform-oriented textbooks/programs. Some observed classes used materials developed by another school district or teacher-developed materials, such as a mathematics lessons based on an inquiry workshop the teacher had previously attended. However, the majority of the observations found classes using LSC-designated including FOSS, Insights, AIMS, Life Lab, and Delta Science Modules in science; and Mathlands, Teach-Stat, Connected Mathematics Project, Core Plus Mathematics Project, and Investigations in Data, Number and Space in mathematics.

As might be expected, the quality of use of these materials varied greatly among observed classes. Just because a teacher was using exemplary materials did not guarantee a well-implemented lesson. Problems noted by observers included classroom management issues, the failure to make the connection from the hands-on activity to the mathematics or science involved, and the noticeable lack of content knowledge on the part of the teacher that hindered the discussion of the underlying mathematical or scientific concept. Many lessons, although having students actively engaged with the materials, remained very teacher directed with little student-to-student discussion or explanation of ideas.

Observers did note some classes where materials were being well-implemented. For example, in a fifth grade "Mathlands" lesson on fractions, students worked in pairs, using the cards to create fractional numbers with differing numerators and denominators. Students then decided where each would go on a number line and drew a pictorial representation. The observer noted that the students had a lot of input into the design of the investigation and were required to support their decisions concerning where to place the fractional numbers. The lesson was characterized by much on-task discussion among the students and many higher level questions from the teacher. It was described by the observer as "dialogue rich," with a good balance of activity and discussion.

Many evaluators commented in their annual reports (as noted elsewhere in this report) that they noticed increased use over the life of the project of the LSC-designated materials, and that teachers were attempting to implement these materials as designed. Many, however, were still at the somewhat uncomfortable phase of "mechanical" implementation. With additional practice and LSC support, the overall quality of the lessons observed should improve as teachers increase their knowledge of the science or mathematics involved and become more facile at classroom management.

Classroom Activities

Evaluators were given a checklist of possible class activities and asked to indicate the ones that were included in the observed lesson. As can be seen in Table 19, elementary mathematics and science lessons were more likely to include hands-on activities and class discussions than formal

presentation by the teachers. In contrast, 7–12 mathematics teachers were about equally likely to use formal presentations and investigative activities.

Table 19
Instructional Activities in Observed Classes

	Percent of Lessons		
	K–8 Science	**K–8 Mathematics**	**7–12 Mathematics**
Investigative activity	**81**	**88**	**68**
Hands-on	78	54	14
Problem-solving/proof and evidence	17	62	59
Class discussion	**61**	**57**	**26**
Formal presentation by teacher	**49**	**54**	**76**
Reading/writing/reflection	**48**	**37**	**49**

Quality of the Lessons Observed

For Cohorts 1 and 2, evaluators observed lessons taught by teachers who had already participated in LSC professional development. Many of these lessons were quite strong (ratings of 4 or 5) in the extent to which:

- Active student participation was encouraged and valued (74 percent);
- The content was appropriate for the purposes of the lesson and developmental level of the class (68 percent);
- The mathematics/science content was significant and worthwhile (67 percent);
- Teacher-presented information was accurate (67 percent);
- The teacher was confident in his/her ability to teach mathematics/science (67 percent);
- The teacher was cognizant of prior knowledge of students (66 percent); and
- There was a climate of respect for students' ideas, questions, and contributions (65 percent).

In contrast, relatively few of these classes were highly rated for the extent to which:

- Adequate time and structure were provided for reflection (37 percent);
- Appropriate connections were made to other areas of mathematics/science, to other disciplines, and/or to real-world contexts (37 percent);
- Intellectual rigor, constructive criticism, and the challenging of ideas were valued (36 percent);

- The lesson was modified as needed, based on teacher questioning or other student assessments (33 percent);

- The teacher's questioning strategies were likely to enhance the development of student conceptual understanding (31 percent); and

- The degree of closure or resolution of conceptual understanding was appropriate for the developmental levels/needs of the student and the purposes of the lesson (22 percent).

Summary

❑ Questionnaire data describe a targeted population of teachers who have positive attitudes towards standards-based mathematics and science education, but in some cases do not feel well prepared to implement these practices. Lack of preparedness is particularly evident in K–8 science, where fewer than half of the teachers feel well prepared to teach topics from the earth and physical sciences.

❑ Classroom observations provide insight into areas of strength of LSC teachers and areas of particular difficulty. Lessons taught by teachers who had participated in at least 20 hours of LSC professional development tended to focus on significant content that was at an appropriate level for their students; the teachers seemed to have a good understanding of their students' prior knowledge and teacher-presented information was generally accurate. Moreover, teachers were able to establish a classroom culture of active participation and respect for students' ideas.

❑ Other areas are proving more problematic. Interestingly, these mirror some of the same areas that have proven problematic in quite a few of the LSC professional development activities: adequate time and structure for reflection; using questioning strategies that are likely to enhance the development of conceptual understanding; making appropriate connections; valuing intellectual rigor and the challenging of ideas; and providing an appropriate degree of closure.

❑ It will be important for LSC project staff to focus on these problematic areas in planning professional development programs, not only modeling effective practice in the context of the designated instructional materials, but also taking the time to make these practices explicit, as well as providing teachers with opportunities to develop skill in their use.