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

A. Introduction

The "theory of action" underlying the Local Systemic Change initiative argues that providing teachers with well-designed opportunities to 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. The previous sections of this report described the nature and quality of the LSC professional development as assessed by project evaluators, based both on their own observations and on data provided by participants. We now turn to an examination of some of the outcomes of LSC projects, including the extent to which the LSC professional development has impacted teacher attitudes, beliefs, and preparedness. The next section will look at the extent to which participation in the LSC is affecting classroom practice.

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. 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.

B. Views on Student Learning

Teacher interview data contained many references to how participation in LSC professional development changed the ways teachers thought about how students learn, which in turn impacted the ways they viewed their instruction. Teachers' comments reflected a heightened awareness of differences among students in both extent of prior knowledge and learning styles. In addition, a number of teachers mentioned changing their ideas about how much time students need to make sense of unfamiliar mathematics and science concepts, as the following quotes illustrate:

> *I've developed more patience with my kids; I'm not in as much of a hurry to get through things as I was before because I'm waiting for the understanding to come.*
>
> * * *
>
> *I have re-learned the importance of allowing time for the students to construct meaning. It is a waste of precious time if students don't have an opportunity to pull things together and make sense by discussing it with others.*
>
> * * *

It gave me a better understanding of the learning styles in my classroom. It made me more aware that different children have different needs. Some kids who need time to think about things longer need longer wait time.

Some teachers reported that participation in the LSC had changed their beliefs about their students' ability to think mathematically, problem-solve, and benefit from using an inquiry approach.

It gave me an opportunity to see students' potential capabilities and not get stuck on kids' mechanics. I learned the value of students' ability to think and reason about mathematics. Because of my experience in the project workshops, I used more word problems with my students, and asked them to tell me how to solve them. I found out that a student who was hampered by not knowing his number facts was a great math "reasoner."

* * *

A highlight was seeing the kids actually come through with the higher level thinking skills and problem solving that they came up with themselves that we would have never known they were capable of doing if we hadn't taught them that way.

As a result, teachers now talk about "how to challenge students to think" and "being able to pull back and give them time to think."

Participating in LSC professional development also made some teachers feel they could more closely identify with their students and thereby better meet their needs. For example, by taking part in a session that focused on cooperative learning or approaching a problem in a variety of ways, teachers could get an experiential sense of how they could similarly engage their students. As one teacher said,

The seminars put me in the position of the kids. I learned how it feels to write and reflect and think about mathematics. I could see how other people saw things, how useful it is to work with other people, and how much you learn from each other. The group work at the seminars was like my classroom because each group had high and low performing members. You realize it's a teaching situation as well; you have to explain your thinking and that helps internalize the learning.

A number of evaluators documented the impact of LSC professional development on the attitudes of special education teachers. An evaluator of a secondary mathematics project wrote:

The most dramatic impact of the LSC on teachers' attitudes and beliefs seems to be among the special education teachers who are participating in this project. They have come to understand and witness that the children they support can and do think mathematically, can engage in problem-solving experiences and function well in classrooms that use an inquiry approach to instruction. One special

education teacher shared the following sentiments: "I see that there is a difference in students' willingness to share answers…[The project has provided] renewed awareness of the damage that can be caused by telling students how to think about problems."

Other teachers were less convinced that the LSC program could work with students of varying ability levels, expressing concern both about heterogeneous grouping practices and the inclusion of special education students in regular classrooms.

I still have questions on how to deal with the inclusion child in the classroom ….We need help on how to deal with these kids, whether it involves having an aide or a tutor in the room, or if we can't have that, then I need help on how to do this program with my mainstream children and inclusion children at the same time.

* * *

I need help knowing how to handle heterogeneous classes (which are mandated to begin in our school next year).

* * *

How to resolve the ability issue in totally heterogeneous groups. The kids at the bottom can't get it—do we modify the curriculum or what?

Teacher questionnaire data, from a much larger number of teachers, indicate that secondary teachers are more likely than elementary teachers to favor grouping of students by ability levels. (See Figure 25.)

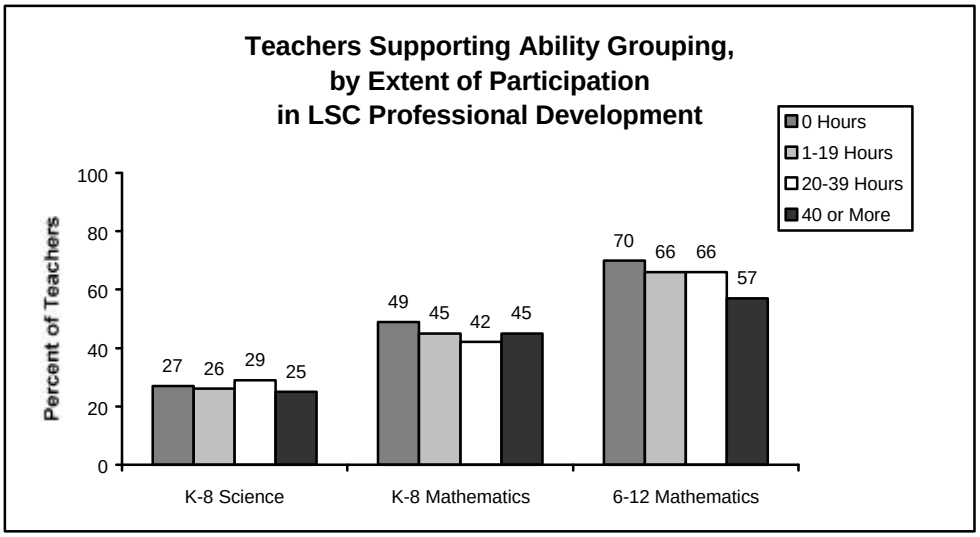

Figure 25

C. Attitudes toward Mathematics/Science Instruction

Participating in LSC professional development provided teachers with opportunities to think about teaching from different perspectives. In interviews, teachers described how they appreciated having the opportunity to reflect on their own thinking about mathematics/science. As one teacher said, "One thing that the LSC has done is that it has really allowed me a chance to stop and think about how important math has been in my life and is still being used in my life."

A number of experienced teachers talked about how the LSC had revitalized their teaching.

> *After teaching 12 years, maybe I was in a rut, I don't know, but it has made teaching fun again. I'm enjoying it.*
>
> * * *
>
> *It has made me eager. I am a veteran teacher (I can retire), but it has made me eager to want to keep teaching.*

Another teacher described the LSC professional development as having had a transformative effect on her:

> *Since attending the teacher institute in July, I have realized that teaching mathematics for understanding is much more complex. Teaching mathematics was at one time the act of opening the teacher's guide book and following lessons that the text provides. Thus, my views of teaching mathematics revolved around teaching the required grade level skills one by one in hopes that all of the skills would be covered by the end of the year. I have always felt that if I was able to "touch" on all the lessons/skills in the text, then I must be successful at teaching mathematics. Listening to [the professional development provider] share her beliefs and experiences helped me realize that my job was to facilitate learning and understanding. My students do not need to be just taught mathematics, but also they need to experience, understand, and question mathematics.*

Results on a composite of several items related to teachers' attitudes toward standards-based teaching indicated a small, but significant difference for both elementary science and secondary mathematics teachers, with the most highly treated group having more reform-oriented attitudes than do untreated teachers.[7] (See Figure 26.)

[7] See pages 7 and 8 for a description of how composite scores were calculated. Results by treatment level are presented separately for K–8 science, K–8 mathematics, and 6–12 mathematics teachers. The effect size is calculated as the difference between the "0 hours" and "40 or more hours" group means, divided by the standard deviation of the population. Following standard conventions, effect sizes of .2 are considered small effects, .5 medium effects, and .8 large effects (Jacob Cohen, *Statistical Power Analysis for the Behavior Sciences*, Hillsdale, NJ: Lawrence Erlbaum Associates, 1988).

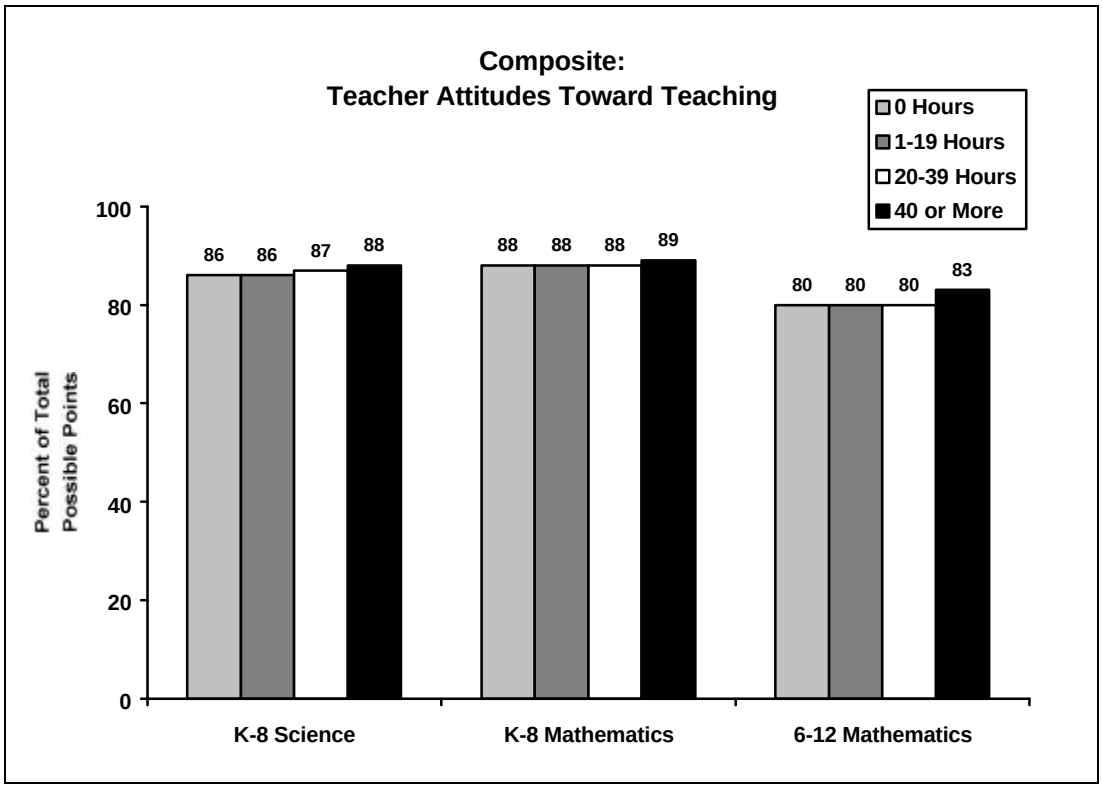

Figure 26

A number of evaluators stressed the importance of viewing how LSC professional development impacts teachers' attitudes and beliefs from the perspective of the overarching rationale for changing their instruction. Evaluators found that, as teachers became more comfortable and confident with content and pedagogy of the curriculum, they began to make critical shifts in their thinking, which went beyond the benefits of "doing hands-on activities" to a broader understanding of ideas. However, a co-director of an elementary science project cautioned:

> *Not all teachers appear to have a complete picture, yet, of the purposes for engaging students in their own investigations; many believe that "hands-on" is effective because it "motivates" students to learn. Teachers previously didn't know about this kind of learning and how motivating it was to kids, and how well children remember what they've done. Once they've tried it, teachers begin to believe it is better than textbooks and telling. Still, they mostly see it as a way to keep kids interested rather than focus on kids' learning.*

D. Teacher Perceptions of Their Preparedness

Data from evaluators' observations and teacher interviews provided important insights into how LSC professional development impacted teaching capacity throughout the projects. Opportunities to strengthen their knowledge of mathematics/science content, as well as learning new instructional strategies, had positive effects on teachers' perceptions of their preparedness to deliver high-quality instruction, although there continues to be considerable room for improvement.

Deepening Content Knowledge

Teachers felt empowered by professional development opportunities which not only provided them with necessary content but made them feel more capable of acquiring such knowledge on their own. One evaluator said:

> *As teachers improve their content knowledge, their overall preparedness and confidence increases. One teacher expressed enthusiasm for the opportunity to learn more science than she was expected to teach her students. In the past, she had felt that she was always "just a few pages ahead of them" without the background or resources necessary to address student questions that went beyond the content of the textbook.*

Participating in LSC professional development appears to have had a dramatic impact on elementary teachers' feelings of preparedness. As can be seen in Figure 27, 86 percent of K–8 science teachers who had participated in at least 40 hours of LSC professional development indicated they were at least fairly well prepared to teach science, compared to 65 percent of those who had not yet participated in LSC professional development.

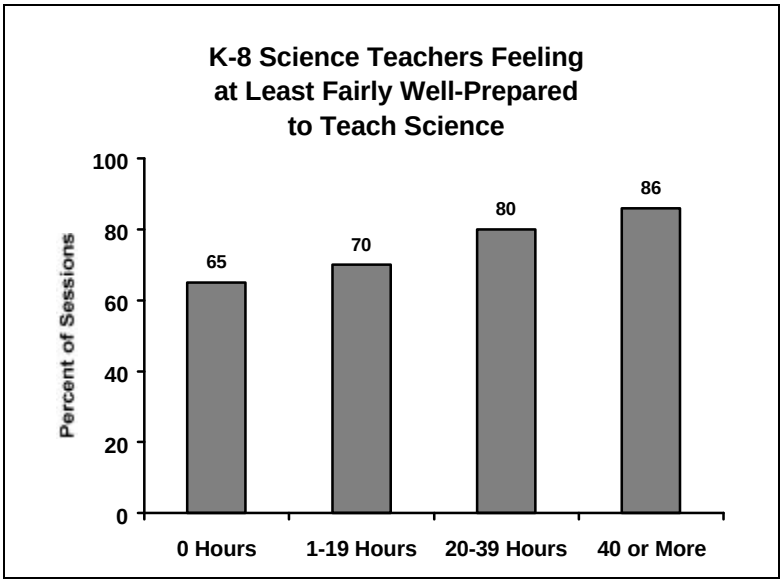

Figure 27

In mathematics, roughly 90 percent of K–8 teachers without 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 28, the trend for mathematics teachers is similar to that for science teachers. Fifty-nine percent of K–8 mathematics teachers who had participated in at least 40 hours of LSC professional development indicated they were very well prepared to teach mathematics, compared to 47 percent of those who had not yet participated in LSC professional development.

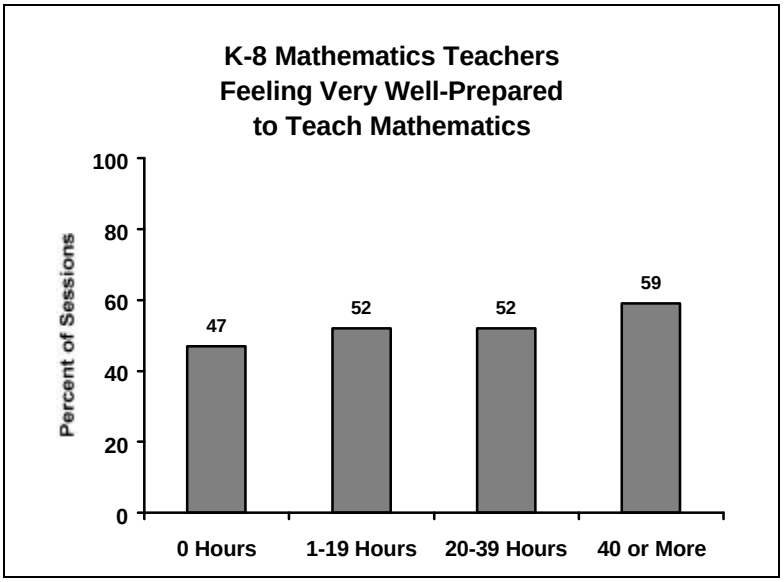

Figure 28

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 all the 11 topics listed. (See Table 7.) Differences were largest for ecology, forces and motion, sound, rocks and soil, and mixtures and solutions, with effect sizes between .22 and .26.

In K–8 mathematics, teachers with 40 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 9 of the 11 topics listed. The largest differences were in probability and estimation, with effect sizes of .20 and .28, respectively. (See Table 8.)

Participation in LSC professional development appears to have somewhat less of an impact on secondary mathematics teachers' perceptions of their content preparedness, with only 5 of 16 topics showing significant differences between untreated and highly-treated teachers; the largest effect sizes, ranging from .18 to .21, were for data collection and analysis, probability, and patterns and relationships.

Table 7
K–8 Science Teachers Feeling at Least Fairly Well-Prepared to Teach Each Topic by Extent of Involvement in LSC

	Percent of Teachers				
	0 Hours	1–19 Hours	29–39 Hours	40 or More	Effect Size
The human body	66	65	72	73	.14
Ecology	58	56	62	70	.26
Rocks and soils	47	46	54	60	.25
Sound	41	42	46	54	.25
Astronomy	41	39	44	44	.04
Forces and motion	38	37	47	51	.26
Mixtures and solutions	38	37	40	49	.22
Processes of change over time	38	35	39	43	.10
Machines	36	36	42	45	.18
Electricity	35	34	41	44	.18
Engineering and design principles	21	19	23	28	.16

Table 8
Mathematics Teachers Feeling at Least Fairly Well-Prepared to Teach Each Topic by Extent of Involvement in LSC

	Percent of Teachers									
	K–8 Mathematics					6–12 Mathematics				
	0 Hours	1–19 Hours	29–39 Hours	40 or More	Effect Size	0 Hours	1–19 Hours	29–39 Hours	40 or More	Effect Size
Computation	95	95	98	97	.13	98	95	99	98	
Patterns and relationships	92	92	96	94	.08	88	91	91	94	.21
Measurement	89	91	91	91		95	95	96	95	
Numeration and number theory	88	88	94	93	.18	88	89	91	91	.10
Estimation	87	89	91	95	.28	95	94	92	95	
Geometry and spatial sense	83	84	86	86	.07	85	83	86	86	
Data collection and analysis	81	80	88	86	.15	76	81	83	83	.18
Probability	66	69	74	75	.20	71	71	79	79	.19
Pre-Algebra	59	60	69	66	.16	92	93	94	92	
Technology in support of mathematics	59	61	61	62		59	62	55	55	
Algebra	45	47	54	49	.09	88	87	90	85	
Functions and pre-calculus concepts	—	—	—	—	—	66	62	62	58	
Statistics	—	—	—	—	—	47	53	55	54	.13
Topics from discrete mathematics	—	—	—	—	—	36	37	41	33	
Calculus	—	—	—	—	—	34	32	27	24	
Mathematics structures	—	—	—	—	—	28	28	23	20	

When the various topic areas were combined into a single composite score, K–8 science preparedness ratings ranged from 57 percent of total points possible for teachers with no treatment to 62 percent for teachers with 40 or more hours LSC professional development, a small effect size (.27 standard deviations). Similarly, the differences between 70 percent of total points possible with no treatment and 74 percent with 40 or more hours of K–8 mathematics treatment represents a small effect (.20 standard deviations). There were no differences in perceptions of preparedness at the 6–12 level in mathematics.

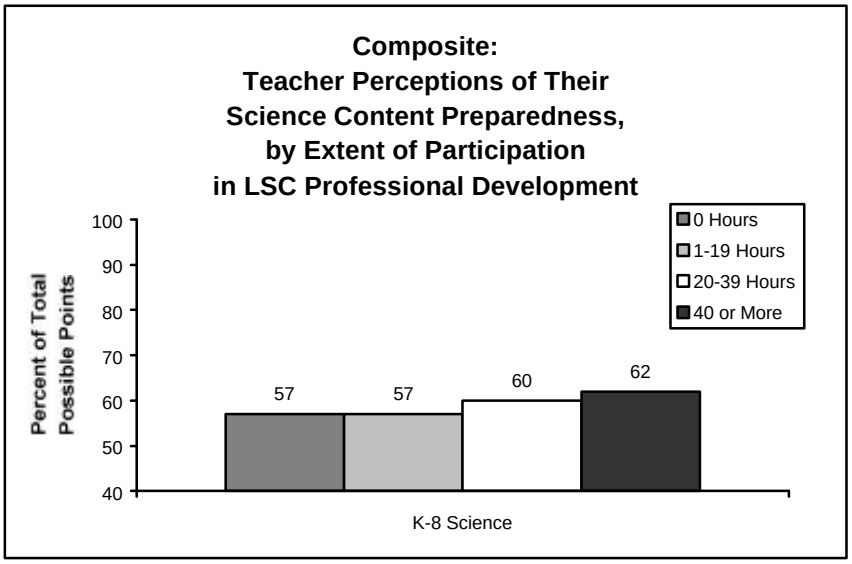

Figure 29

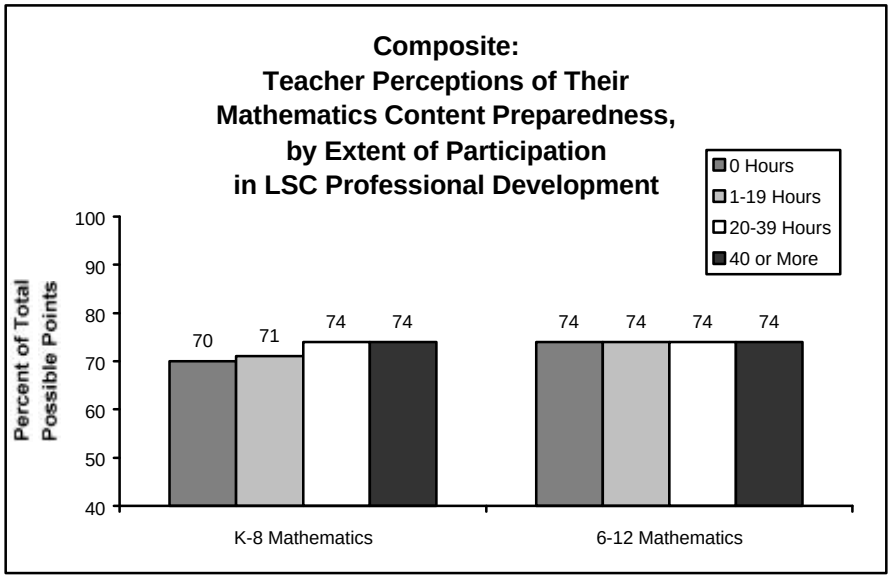

Figure 30

When asked about the "most helpful" aspect of the LSC, a number of teachers cited their increased mathematics/science knowledge:

> *The sessions have helped me put it all together, increasing my understanding of the science content and how to better use the kit-based science program.*

Similarly, when asked about the major impacts of the LSC, some teachers singled out impact on their content knowledge.

> *It's made me grow as a teacher mathematically, as a person mathematically. I can solve problems a lot better.*

A number of evaluators noted how LSC professional development enabled teachers to view themselves as scientists or mathematicians, capable of learning, researching, and investigating sophisticated concepts. In addition, teachers appreciated relating content to real-life situations, as the following quote illustrates:

> *This grant has helped in my content preparedness. It has given me a better grasp of the conceptual underpinnings that we are trying to get across to the children. The training has helped me tie concepts together in a more unified way. For example, I began to think of flow of energy concepts in lots of everyday applications and discuss them with the students. I no longer teach concepts in isolation.*

Willingness to Modify Pedagogy

By reflecting on their own participation in LSC professional development activities, teachers were motivated to consider changing their pedagogical practices. Experiencing the instructional materials first-hand not only raised their confidence levels, but also made teachers feel connected to how students learn. For example, one teacher in a K–12 mathematics project said:

> *I've done more cooperative grouping, because I found out it felt good having the support of the group rather than working on my own and getting frustrated. It opened my eyes. It made me more empathetic toward students who were having a difficult time.*

Evaluators found that teachers felt more confident about teaching mathematics/science after participating in LSC professional development activities, and as a result, a number of them reported a newfound appreciation for the subject as well as for teaching in general. Many teachers reported that opportunities to strengthen their content knowledge increased their self-assurance, which in turn helped them to rise to the challenges of trying new instructional strategies.

> *I am comfortable teaching science for the first time in 20 years.*

* * *

The seminars were a breath of fresh air. I went back to the classroom with more confidence about teaching mathematics, and excited about doing the new lesson.

Some teachers expressed appreciation for the "big picture" of the reform, both the theory behind it, and how the ideas unfolded across grades.

The most useful is the organization kind of spelling out the whole principles behind engaging and exploring and the various concepts behind inquiry-based science.

* * *

It's been very important having an overview of the modules before we get started. Seeing what children are going to do helps me plan, helps me be able to plan. It gives me an idea of where we're going. I don't like to only do it one step at a time.

* * *

We didn't have a real good science curriculum to begin with, and we were just kind of pulling from here and there. This gives me a map and I know where I'm going and there is a real purpose to my science instruction.

A number of evaluators wrote of how participation in LSC professional development motivated teachers to move outside their comfort zone and try new instructional strategies. As two teachers from different K–8 science projects said:

I've always believed in hands-on instruction but as a result of this grant I am even more convinced now. It has given me the incentive I needed to be a better risk taker. Now I really do take the kids outside for those field experiences.

* * *

Before the LSC I would just use the textbook, just read the chapters and rarely did any experiments, especially if it seemed difficult or required a lot of supplies. Now, I use the kit and teach science as much as I can. I found it hard to teach science before, now it is much easier and it makes me want to learn more. I feel like I am learning with my kids.

Questionnaire data 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 31.) Similarly, at the elementary (but not the secondary) level, teachers who had participated in 40 hours or more of LSC professional development were more likely than their untreated peers to indicate that they enjoy teaching mathematics/science.

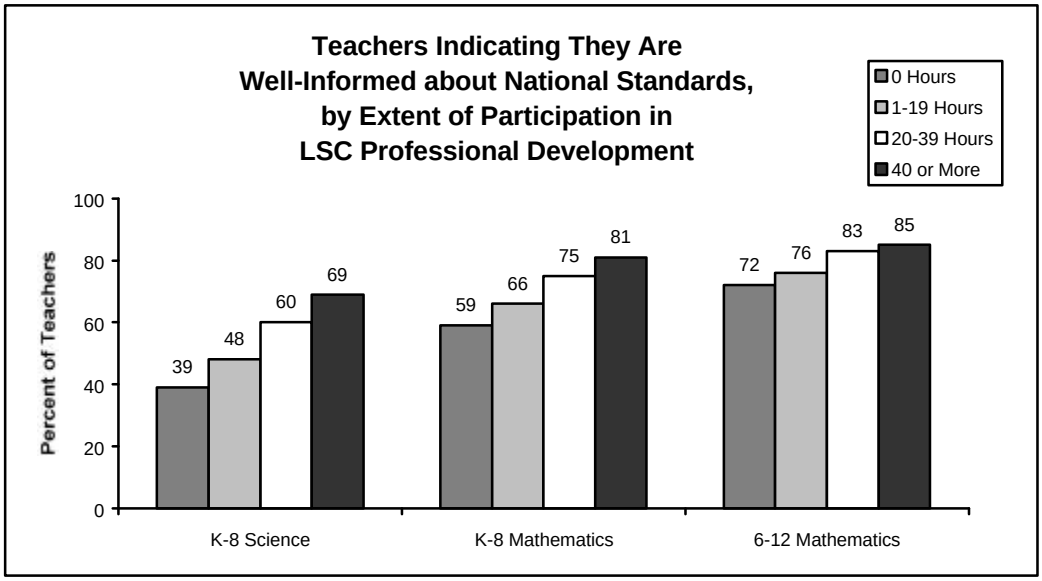

Figure 31

Figure 32 shows the results on a composite of items about teacher preparedness to use a variety of instructional strategies in their mathematics/science instruction. The seven percentage points difference between untreated and highly-treated K–8 science teachers (.52 standard deviations) constitutes a medium effect, and the four-point difference for K–8 mathematics teachers (.25 standard deviations) a small effect; there was no significant difference for 6–12 mathematics teachers.

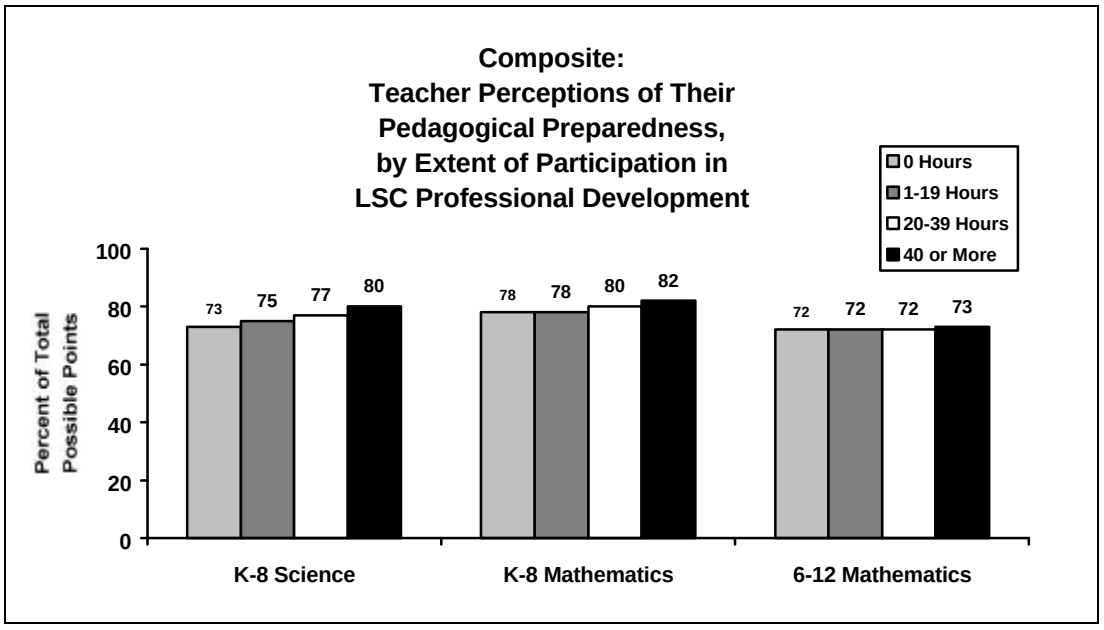

Figure 32

E. Concerns About the Appropriateness of the Instructional Materials

In some projects, evaluators report, teachers are not convinced that using the designated instructional materials is in the best interest of their students. In particular, teachers expressed concerns about the need to include "the basics." For example, the evaluator of a K–12 mathematics project reported that while primary teachers were comfortable with the new mathematics curriculum (which emphasizes the development of conceptual understanding), intermediate and middle school teachers thought there was too little emphasis on basic skills.

Teacher comments included the following:

> *I'm really torn. I know application is important but some kids come with low ability. They have no foundation so they can't apply things. You just can't throw out the basics.*
>
> * * *
>
> *In some cases the implementation is going overboard, the materials are used at the expense of the basic skills, whereas it should be used as a vehicle for learning the basic skills.*
>
> * * *
>
> *I want to balance it with drill. I think students need a little drill, a little manipulative, a little paper and pencil, and then see what works best for the individual kid.*

In science, teachers sometimes longed for more of an emphasis on reading about science.

> *In this new science program, children don't have much reading to do. The activities go through such a convoluted process to make the point that children get lost along the way. All the hands-on is not necessary. Kids love to read about science.*
>
> * * *
>
> *I wish there was a textbook that the students could keep in their desk and take home.*

In other cases, teachers are in agreement with the general philosophy underlying the LSC, but consider the particular instructional materials to be developmentally inappropriate for their students. For example, an evaluator of a K–8 science project reported teachers' dissatisfaction with a number of the kits intended for the early grades.

> *One third grade teacher told about her frustration in dealing with concepts of measurement in the Time and Measurement kit. Her students were not able to*

understand the concepts. The unit lessons bogged down on data collection to the point that the teacher said that the students missed the point of how the data fit into the overall scheme of things.

A second grade teacher talked about her frustration in working with the Plant Growth and Development kit. Her students lacked the fine motor coordination necessary to plant the seeds successfully. Consequently, many seeds died. She was faced with disappointed students who had an experience of failure in science. This was not the message she wanted to give.

A third grade teacher from the interview sample commented: "I need to have the Changes of State Unit revisited. It needs modification in order to make it appropriate for third graders. The kids need a foundation knowledge about solids, liquids and gases. The kit makes too many assumptions about the prior knowledge level of the students. They need to revisit this kit. I'm no curriculum expert, but I think that the match between the kit and the students is not as good as it could be."

Lack of alignment between the LSC vision and the district test created conflicts for other teachers; they may find the LSC program valuable, but still not be able to implement what they learn.

I mean, you just stop and MathLand goes away for a little while because you know that there're going to be tested and they have to know the answer right away…And, the thing that bothered me was that they're second graders [and] that maybe they have another way to figure out the problem, but, I was imposing that algorithm. I'm telling them this is the way to do it. This is the way you need to find the answer quickly. So, do it this way. I don't want to do that. I want to go ahead and let them do it the way they can do it. Then again, I want them to do well on the test. So, I feel this conflict. It's major conflict.

* * *

In our system there is a lot of attention to the test. A lot of information on the test is not covered in the modules. That could be something looked into. Especially with certain grade levels. At first, I was a little apprehensive, but the kids really enjoy it. It is good for kids to manipulate things, it's really helpful. It helps with the scientific process. I enjoy the program; I just wish it could correlate better with the SAT tests. Some of the things that are taught in [LSC] are really great, but a big focus is placed on the test, so if [LSC] is teaching something that is not on the test, it becomes secondary. It might be seen as a waste of time, even though I don't think it is. I think it's all important, and the kids need to know it, but because of the test it is considered unimportant.

F. Too Many Demands, Not Enough Time

When teachers were asked about the "least helpful aspects of the LSC," they frequently cited a lack of time. Many teachers expressed a concern about time out of the classroom, and the difficulty in arranging substitutes, in some cases deciding not to participate in sessions that required them to be out of the classroom.

> *The only thing that wasn't helpful was having to leave the classroom for a full day to attend workshops. I'm away from the kids for a whole day and the kids go crazy when I'm not there.*

* * *

> *This grant was costly as far as time is concerned. I had to get everything ready for a substitute teacher on the days when I was going to be gone for training. I hate to be away from my classroom. When I returned I was never sure if what the substitute teacher had done was consistent with what I do.*

* * *

> *I decided not to go to the rest of the kit classes because I did not like leaving my classroom for more than four days….I do plan on going to kit classes this summer to get the information, and that way I won't be away from my classes.*

Other teachers indicated that the lack of time to process what they had learned was a limiting factor.

> *I got a lot of good ideas. The problem is, I haven't had time to do anything with that information. I plan on using it—later.*

* * *

> *I have the skills, but not the time. I should probably take everything again because I haven't had time to implement things and have forgotten information that I learned.*

Still, other teachers talked about the extra demands of teaching using the LSC materials and approach. Said one elementary teacher of her science instruction:

> *I like hands-on, but I think it's a lot of work.*

Finally, some elementary teachers expressed concern about the scope of the instructional materials they were expected to teach, worrying that they were "robbing another subject."