PROGRESS AND PITFALLS:
A CROSS-SITE LOOK AT LOCAL SYSTEMIC CHANGE
THROUGH TEACHER ENHANCEMENT

by

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Introduction

In 1995, the National Science Foundation (NSF) initiated the Local Systemic Change through Teacher Enhancement program. The initiative’s primary goal is to improve instruction in science, mathematics, and technology through teacher professional development within whole schools or school districts. NSF funded the first cohort of Local Systemic Change (LSC) projects in 1995, and an additional cohort of projects each year, with a total of 87 projects funded by 2001.

The LSC initiative distinguishes itself from former NSF-supported teacher enhancement efforts in two important ways. First, it targets all teachers in a jurisdiction for professional development; each targeted teacher is to participate in a minimum of 130 hours of professional development over the course of the project.¹ Second, the LSC emphasizes preparing teachers to implement project-designated exemplary mathematics and science instructional materials in their classes.

In addition to providing professional development for teachers, the LSC initiative promotes efforts to build a supportive environment for improving science, mathematics, and technology instruction. LSC projects are expected to align policy and practice within targeted districts, and to engage in a range of activities to support reform, including:

- Building a comprehensive, shared vision of science, mathematics, and technology education;
- Conducting a detailed self-study to assess the system’s needs and strengths in relation to that vision;
- Promoting active partnerships and commitments among an array of stakeholders;
- Designing a strategic plan that includes mechanisms for engaging teachers in high quality professional development activities over the course of the project; and
- Developing clearly defined, measurable outcomes for teaching, and an evaluation plan that provides formative feedback and assesses summative results.

NSF’s solicitation for the LSC initiative indicated the Foundation’s interest from the outset in providing a framework for collecting data from LSC projects to evaluate their efforts. The goal of the evaluation activities was not only to assess individual projects, but also to aggregate data across projects to glean broader insights about the design, quality, and impact of the LSCs. NSF contracted with Horizon Research, Inc. (HRI) in Chapel Hill, North Carolina to develop a data collection framework, to provide technical assistance in implementing evaluation activities, and to prepare cross-site analyses of evaluation results.

Since the LSC’s inception, HRI has collaborated with NSF staff, LSC PIs, and project evaluators on the design and implementation of a core evaluation system. The system includes the collection of Baseline Year data during an LSC’s first year of funding, and a range of data

¹ Prior to 1999, NSF required only 100 hours for teachers in K–8 projects.
collection activities during subsequent years. Evaluators are asked to provide comprehensive evaluation reports in Year Two and the Final Year of their projects, and less detailed reports in the interim years.

All of the evaluation activities are driven by a set of 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 on classroom practices in mathematics and science?
- To what extent are the district and school contexts becoming more supportive of the LSC vision for exemplary mathematics and science education?
- What is the extent of institutionalization of high quality professional development systems in the LSC districts?

This report is based primarily on the analysis of comprehensive evaluation reports from 61 LSC projects, including 17 reports from 1998–99, 17 from 1999–2000, and 27 from 2000–2001. The evaluator reports blend data from core evaluation observations, interviews, and questionnaires. In some cases, evaluators used additional information in preparing their reports, such as project-specific questionnaires and studies of special components of the projects. Also included are data from HRI’s cross-site analyses of teacher and principal questionnaires, teacher interviews, classroom observations, and professional development observations. Finally, HRI conducted in-depth interviews with PIs of ending LSCs in 2000, 2001, and 2002, and these data are included in this report.

The following sections include discussions of LSC professional development providers; the extent to which LSCs have created a culture conducive to teacher learning; the quality and impact of LSC professional development activities; and the extent of support for, and institutionalization of, LSC reforms. “Highlights” after each section recap the key points about these topics. In the last section, we summarize the major findings in this report, and provide a number of recommendations for improving the LSC program.

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2 See Appendix A for a description of core evaluation data collection activities.

3 LSC evaluators prepare comprehensive reports at two points, at the end of their second year and at the end of the project. A total of 61 projects submitted comprehensive reports during this period. Thirty-one of the 61 projects focused on science, 26 on mathematics, and 4 on both science and mathematics. Thirty-three projects were in their second year of NSF funding, while 28 were completing their final year.

4 See Appendix A for data included in this report.
Professional Development Providers

- Who Provides Professional Development?
- Preparation of Professional Development Providers
- Support for Professional Development Providers

LSC projects are expected to prepare teachers to implement exemplary instructional materials and use inquiry-based practices in their classrooms. In large part, the success of these efforts lies with LSC professional development providers who are entrusted with conveying a new vision of teaching and learning to teachers. Beyond this vision, providers must develop teachers’ confidence and capacity to use new instructional practices, hands-on materials, and alternative assessment practices—all in the service of helping students learn important mathematics and science concepts. This section looks at who provides LSC professional development, and how LSC projects prepare and support these providers in their roles.

Who Provides Professional Development?

LSC projects continue to involve multiple kinds of professional development providers to meet the varied needs of large numbers of targeted teachers. Among the types of providers named in evaluation reports were:

- District-level personnel, including mathematics/science supervisors;
- Teachers on special assignment, released full time from their classroom responsibilities;
- Teachers who were providing professional development in addition to their full- or part-time classroom responsibilities;
- University faculty, including mathematicians and scientists, as well as mathematics and science educators;
- Museum staff; and
- Authors/publishers of instructional materials.

Among these various professional development providers, teachers on special assignment (TSAs) are the “backbone” of LSC projects, playing predominant roles in planning and implementing professional development. Released full-time from their teaching assignments, teacher leaders at this level plan activities for targeted teachers; facilitate district- or project-wide workshops and school-based study groups; and provide coaching and mentoring to individual teachers. As former teachers, TSAs bring classroom experience and credibility to reform efforts. Many also bring prior experiences as professional development providers, and have been selected by LSC staff precisely because they have already distinguished themselves as leaders in their schools and districts. Said one evaluator about the project’s teachers on special assignment: “[Their] many years of successful mathematics teaching and mentoring, their experience, their knowledge of the subject matter are all evident by their manner of presentation, their thoroughness, and their varied use of approaches.” This description reflected the view of many other LSC evaluators as well.
A second tier of teacher leaders—those who maintain their classroom teaching assignments during the LSC—play ever-expanding roles in LSCs, particularly as projects near the end of their funding. Primarily, these teacher leaders team with experienced professional development providers in facilitating workshops, and provide on-site support to their colleagues. As LSCs mature, they have devoted more effort to identifying teacher leaders at this level—to build “internal” expertise, to assist core staff as projects scale up, to increase visibility for reform in schools and communities, and to broaden the base of leadership to sustain reform.

LSCs also tap university and/or industry scientists and mathematicians—specifically for bolstering the content needs of participants—and touted both the qualifications and level of commitment these experts bring to their charge. Said this evaluator:

_Deepening content knowledge was the primary charge for an experienced and dedicated group of Project Scientists, most of whom came from the science faculty at [University]. They included specialists in science, environmental science, physics and astronomy, geology, chemistry, and biochemistry….These professionals have exceptional credentials and experience in their science specializations and they comprise the core of what has been a very effective cadre utilized to help teacher participants increase their knowledge and deepen their understanding of science content….They have been part of a consistent professional team that has learned together, created together, and grown together in their ability to provide high quality professional development._ (Evaluator, elementary science LSC)

In working with targeted teachers, professional development providers address three primary areas—content preparation, familiarizing teachers with new instructional strategies and materials, and providing ongoing support to teachers during implementation. NSF was particularly interested in how these responsibilities were divided among the various providers. Given that LSCs often try to weave professional development activities into a “seamless blend” of content, pedagogy, and instructional materials, however, it was often difficult for evaluators to delineate providers’ roles. This blurring of lines was particularly evident in LSCs that employed teams comprised of content experts and teacher leaders, where co-planning and co-facilitation were a deliberate part of the design. The following examples are typical of the ways in which providers shared responsibility for different areas of professional development:

_At the heart of the project are four Discipline Teams, one each for biology, chemistry, physics, and earth science. Each Team is made up of three [lead] teachers and one or more [university] faculty members who specialize in the respective disciplines. Each Discipline Team is responsible for developing course outlines for each of the new science units; selecting, developing, or adapting the corresponding instructional materials; developing formative and summative assignments; and training other science teachers in the district on the use of the selected materials._ (Evaluator, secondary science LSC)

_Teams of two or more instructors shared responsibility for the design and delivery of the workshops. Typically, the entire team addressed issues of pedagogy and materials management while one member, selected for strong content knowledge, took the lead in that area, [offering] mini-lessons around key concepts being addressed in the materials._
But even these responsibilities were shared in many of the workshops. So the roles were less clearly defined than the designation of “content expert” might imply. This blurring of functional responsibilities increased over time as team members gained expertise.
(Evaluator, elementary mathematics/science LSC)

Project staff include former teachers, teachers on leave, and university faculty who share responsibility for professional development and follow-up support... The presenters, in combination with the teacher mentors who visit the classrooms of LSC teachers following the professional development, are responsible for deepening mathematics content knowledge and developing teachers’ pedagogy and skill with the instructional materials. The “division of labor” is blurred between the presenters and the mentors, since mentors are often presenters, too. (Evaluator, secondary mathematics LSC)

Within this teaming format, teacher leaders typically focus on pedagogy and materials, while content experts work to develop mathematics/science conceptual understanding. Evaluators cited examples where these “blurred” responsibilities were carried out flawlessly—when team members played complementary and collaborative roles. They also described cases where the teaming approach was less effective, when professional development providers were unclear about roles or unprepared for their charge.

Preparation of Professional Development Providers

- Developing Awareness: Vision, Goals, Strategies, and Needs
- Communicating Roles
- Developing Knowledge and Skills

LSC professional development providers vary widely in the skills and background they bring to the projects. University faculty sometimes bring considerable prior experience in providing teacher enhancement activities, while others are new to K–12 education. Similarly, full-time teachers on special assignment, as well as part-time, school-level teacher leaders, may have extensive prior experience or they may be recent recruits into the reform process, with limited experience as leaders and facilitators of professional development. Within the LSC, each of these professional development providers can assume an array of responsibilities, and all will need to be prepared for, and supported in, their roles.

In describing effective professional development providers, LSC evaluators and PIs highlighted a number of qualities:

- Providers must fully embrace the tenets of reform;
- Providers must have an in-depth understanding of the content in the designated materials, and a broad awareness of how this content fits into the curriculum as a whole;
- Providers must be knowledgeable and experienced in using LSC instructional materials;
- Providers must be able to model and discuss sound pedagogical strategies; and
• Providers must be adept at working with adult learners, sensitive and responsive to the strengths and needs of participants.

**Developing Awareness: Vision, Goals, Strategies, and Needs**

LSC PIs asserted that the strongest professional development providers have a clear understanding of the project vision for teaching—mathematics and science instruction that is inquiry-based, with rigorous content and relevant applications. Both PIs and evaluators noted the need for LSCs to be proactive in communicating their vision, and to have a formal process for doing so—with teachers on special assignment, school-based teacher leaders, content experts, and others. Some LSCs noted the need to revisit “vision” themes in explicit ways over time, especially in light of the “evolving policy context” and the sometimes-conflicting “visions” that LSCs encounter (e.g., state standards and assessments, teacher evaluation systems).

Evaluator reports suggest that LSCs vary in their attention to building vision among professional development providers. Some projects were vigilant in this area, reinforcing the vision in summer institutes; involving providers in regularly scheduled planning meetings; and providing mentoring by core staff and/or experienced teacher leaders. Other LSCs developed specially designed “vision” activities, and provided opportunities for ongoing review and “reinforcement,” as described by these evaluators:

*One of the university mathematicians and the three project leaders co-planned the professional development for teacher leaders, teachers, administrators, and parent leaders in regularly scheduled meetings where the vision for mathematics education and the professional development were often reviewed in light of new information from teachers and district administrators, new policy initiatives at the state level, and ongoing feedback from the project evaluators...The co-planning and co-teaching fostered an ongoing process of reviewing and renewing of the project vision for high quality mathematics education and professional development.* (Evaluator, elementary mathematics LSC)

*Evaluators conducted a “vision and implementation” activity during numerous sessions spanning several months over the last year. [Project leaders and teachers on special assignment] participated in clarifying the vision of the project with each other and determining clear and measurable outcomes for each audience in the project....The end result was a much clearer understanding of and commitment to the shared vision and specific implementation strategies of the project.* (Evaluator, elementary science LSC)

*The background of professional development providers, particularly those coming in from outside the county and state, does not always include familiarity with local resources, needs, priorities, and the LSC sequence of professional development. Recognizing these problem gaps...[project staff] oriented all facilitators to goals and the scope of the project, and all were provided with an assistant from the [core team] or a lead teacher for the duration of their sessions.* (Evaluator, secondary science LSC)
Building on a Foundation

LSCs that built on previous reform efforts shared a distinct advantage in developing a clear vision among professional development providers. In these cases, the vision was typically one that had been the foundation for district work over a number of years, and had been “absorbed” by major players in the reform process. For example, from one evaluation report:

[The project] ranks very high on its articulation and clarity of a shared vision of quality science education. The [project] model…was already carefully designed and well organized at the beginning of the LSC. It is not a model that is still under construction. Rather, what to do and how to do it was already well established and ready to implement at the inception. Everyone of the project leaders we interviewed this year and last told us that in their estimation one of the greatest strengths of their LSC was that “there was a game plan” or a “systemic plan” in place as the project began. (Evaluator, elementary science LSC)

In this case, the vision included the short-term goal of implementing a kit-based program, as well as a long-term plan for developing inquiry-based teaching and learning. While core staff must maintain an awareness of how to move this vision forward through their professional development providers, the existing “game plan”—with a proven track record—relieves them of the task of inventing and building awareness of a vision among professional development providers—a task which, according to some PIs, can considerably slow down the implementation process.

Not surprisingly, LSCs try to select professional development providers whose previous work supports the LSC vision. From these evaluation reports:

Project directors are faculty members of the university mathematics department, with many years of experience in mathematics education. They bring not only mathematics expertise, but also a strong understanding of the curriculum materials being used in the project. Additionally, all have previously been involved in coordinating PD programming and facilitating PD sessions. (Evaluator, secondary mathematics LSC)

The project has especially sought out individuals who share its vision of standards-based, inquiry-oriented science instruction to serve as Project Mentors. (Evaluator, elementary science LSC)

PIs selected consultants based on the alignment of their work with the vision of teaching and learning espoused by the project. (Evaluator, elementary science LSC)

The project team is very selective in engaging PD providers with whom they can work well, who share the project goals, who can enact the desired strategies, and who will offer insight and expertise that is not otherwise available within the project team itself. (Evaluator, elementary science LSC)

[The professional development providers] are well-prepared for their roles since all four were initially trained to do professional development by the national IMP staff, the creators of the curriculum. (Evaluator, secondary mathematics LSC)
This strategy is clearly efficient. It builds a core of professional development providers whose own vision is already in alignment with the LSC, and reduces the amount of effort required of LSCs to “bring professional development providers around.” On the other hand, LSCs risk making assumptions about how closely professional development providers share the vision across all project components, including high expectations for all learners, alternative assessment practices, and so on. Said one evaluator of this problem:

*Because of the already high level of experience of the summer session professional development providers, the project overall provides very few professional development opportunities for them. These people are hired for their expertise. There is communication between the project personnel and the providers about the goals of the project. Generally, however, the professional development providers do what they think is best and that may or may not directly match the goals of the project.* (Evaluator, elementary science LSC)

With content experts, LSC PIs noted the need for developing strategies to “get faculty smarter” about the vision, particularly at the elementary and middle school levels. Some projects worked intensively with content experts, stressing the “critical importance of how presentations are designed to unfold,” and bringing them to “full consciousness” about the effect of their style on participants. As with teacher leaders, project leaders also engaged content experts in staff meetings to clarify vision, strategies, and needs of targeted teachers. Finally, LSCs encouraged content experts to visit classes in which teachers were using the designated modules to increase familiarity with inquiry-based materials and practices. Said one evaluator of the challenges and progress made by one LSC:

*The project has had a challenge in identifying and involving the needed number and type of content specialists...Most of these individuals, who come from area colleges and industries, had limited prior experience working with elementary teachers...The orientation session focused specific attention on building an appropriate vision of elementary science teaching and learning. Observations of that session and of content-development sessions at the summer institutes (where scientists interacted with participating teachers) indicate that for the most part, the content specialists have bought into the project’s vision. Their understanding of the vision is not as deep as that of the project mentors, but it is supportive of what the project is trying to accomplish.* (Evaluator, elementary science LSC)

Evaluators also pointed to the need to reconcile “vision” differences between content experts and teacher leaders, for example, about what a “reformed” classroom should look like or the design of content courses. According to PIs, even projects with a long history of working with university faculty on teacher enhancement projects were not immune to these tensions. The pairing of content experts and teacher leaders helped convey a more holistic understanding of the LSC vision to team members: teacher leaders became more grounded in underlying mathematics and science concepts, and content experts gained a better understanding of teacher thinking as well as applications with K–12 students. Establishing effective partnerships sometimes proved challenging, but appeared to be worth the effort. As one LSC staff member noted, “The scientist-classroom teacher partnerships—developing trust, respect, and mutual admiration was...
not easy…It took two to three years to establish [the partnerships] but once accomplished, the
partners developed a camaraderie that has had a great positive impact on participants in the
workshops.”

**Communicating Roles**
LSC professional development providers can assume a wide range of roles—workshop
facilitation, materials review, mentoring and coaching, materials management, community
outreach, and advocacy. These roles can evolve over time, further complicating LSCs’ task of
preparing providers for their responsibilities. As with communicating vision and strategies, LSC
PIs noted the need to be both proactive and explicit. Some had developed a keen awareness of
the importance of assigning roles appropriately, communicating expectations clearly, and
tailoring roles to meet both immediate and emerging needs. As one PI noted, “Being a good
mathematics teacher does not necessarily make one a good communicator, especially regarding
the skills needed to work with administrators, community [members], and others in the area of
mathematics reform.”

**Teacher Leaders’ Evolving Roles**

Typically, teacher leaders move through an evolving set of roles, depending on project
needs—from “cheerleader” and “hand holder” to presenter, mentor, coach, and facilitator.
Some teacher leaders successfully adapt, with the support of the project, as roles become more
differentiated and more demanding. One teacher leader reflected on this transition in the Final
Year of an elementary science LSC: “Six years ago, I was trying to define my role. I was
unsure. I knew I was supposed to help teachers. Now I am a professional development
specialist…I help teachers embrace hands-on inquiry science and use it as a vehicle for change
in all of education…I am a change agent.”

Involvement in regularly scheduled staff meetings throughout the year continues to be the
primary mechanism for defining roles and expectations for professional development providers.
Mentoring, debriefing, and leadership training opportunities also helped clarify participants’
understanding of their roles as leaders and change agents. When these strategies were
insufficient, LSCs looked to other means to communicate roles: preparing written guidelines;
incorporating a more participatory process (e.g., co-planning sessions with teacher leaders and
content experts); and educating core staff responsible for the preparation of professional
development providers. From these evaluation reports:

> These leadership team meetings are an important part of the [LSC’s] ongoing effort to
develop leadership skills within the districts participating in the project. In these
meetings, the facilitators engage the participants in doing an activity and then reflecting
on the role of the facilitator, thus learning to lead such activities. In the March meeting,
considerable time was spent having the leadership teams define the roles of lead teachers
in their own districts and then sharing these definitions. (Evaluator, secondary
mathematics LSC)
Communication of leadership roles and expectations was an ongoing topic of discussion as new roles, including collaborative presentation of four- and five-day institutes, emerged in the third and fourth years. The final joint session for teacher leaders, parent leaders, and administrators included attention to this issue as it applied to work after the completion of the LSC, as described in [this] observation excerpt: Presenters discussed their own roles as leaders in equity and mathematics education reform and leadership from the perspectives of parents, teachers, and administrators...Participants had a number of opportunities to reflect with peers about what they had learned about leadership. These reflections were focused toward the close of the session on what participants saw as future directions for mathematics education reform in the district and what roles they saw for themselves in the continued reform activities. (Evaluator, elementary mathematics LSC)

Evaluators also described some of the challenges LSC staff face in preparing teacher leaders to assume greater leadership roles. Some LSCs were adept at expanding the level of expectation, particularly as projects scaled up and core staff recognized the need for broadening the base of leadership. In contrast, other LSCs were less proficient in clarifying expectations and in providing opportunities for leadership development. For example, in one elementary science project, professional development providers’ roles that were clear-cut during the summer—as workshop planners and facilitators, with clearly assigned tasks—became murkier during the school year, where coaching teachers and assuming school-based leadership roles were unfamiliar (and often uncomfortable) territory for teacher leaders.

In fact, communicating roles remains a challenge to the end, as another evaluator notes in the Final Year of this LSC:

*Over the course of the grant, the project leadership team has worked to clarify roles, while also continuing to redefine them, as project needs have changed—not an easy task. As more teachers served in visible roles at all levels—[school-based teacher leaders to teachers on special assignment]—and, as they simultaneously helped to redefine their emergent roles along with project leaders, concerns about role definitions have diminished, but not disappeared.* (Evaluator, elementary science LSC)

**Developing Knowledge and Skills**

LSCs vary widely in their strategies for developing professional development providers’ knowledge and skills, depending on the providers’ background and their designated roles. For example, some of the teachers selected for teacher leader roles have solid content knowledge but limited experience in working with teachers; others are experienced teachers with limited content background. The challenge for LSCs lays in meeting these professional development providers “where they are,” and designing strategies for enhancing their preparedness accordingly.

Although content experts needed little preparation in subject matter, their limited experiences in working with K–12 teachers often required LSCs to address pedagogical issues. Some LSCs addressed these shortcomings more extensively than others, engaging mathematicians/scientists in intensive training, with clear results. Said this evaluator: “The subject matter experts [still] tend to rely on the lecture format, but have progressed a good deal from training sessions last
year in their ability to use small/large group discussions and hands-on activities… Over the last three years, this evaluator has noticed dramatic improvement in the comfort level that [they] have with the teachers during the training.” In another project, in-depth training for scientist/teacher leader teams included “critical friend feedback” by mentors and debriefings facilitated by a workshop “recorder” who attended each session; according to the evaluator, these activities were instrumental in helping scientists build the knowledge and skills needed to work effectively in the project. In contrast, other LSCs relied only on brief discussions with content experts to prepare them, sometimes to the detriment of LSC workshops.

Teachers on special assignment typically participated in the most in-depth preparation in terms of building knowledge and skills. Among the strategies used were: intensive summer institutes to familiarize teacher leaders with content, pedagogy, and materials; leadership institutes; study groups and action research teams; modeling/mentoring/coaching/debriefing by core staff; and consultant-led sessions on specific topics such as inquiry, equity, and assessment. TSAs also participated with LSC PIs and project directors in national conferences and/or institutes to gain a better understanding of standards, effective professional development, and systemic reform strategies. According to PIs and evaluators, it was not unusual for teachers on special assignment to have participated in “hundreds of hours” of professional development over a period of years.

Preparation for “second tier” part-time teacher leaders included many of the same strategies used with TSAs—typically focusing first on the designated instructional materials and the content and pedagogy that under-gird those materials, but over time expanding to provide more in-depth learning opportunities both locally and nationally. These professional development activities frequently included formats similar to the ones teacher leaders would use with targeted teachers, such as study groups. One LSC used a model that included a series of stages to groom teacher leaders and help them grasp new practices; for example, leaders first attend “basic” workshops, then observe and script workshop sessions, then participate in planning and leadership sessions, and finally, join the core team to design and present sessions.

Ideally, noted PIs, LSCs should “start teacher leaders off easy” and expand leadership roles gradually—for example, through involvement in project planning, materials review, and apprenticing with more experienced staff. Evaluators also pointed out that as LSCs mature, project staff became savvier at matching needs with training opportunities, and expanding roles as knowledge and skills increase. Said these evaluators:

We have the sense that the facilitators were much better prepared for their roles this year. This is in part due to having much more lead time to plan classes, but it is also because the [project] leadership has much clearer expectations for both the science content classes and the facilitators. This year, the project leadership worked closely with each of these facilitators. They gave them a sense of the scope of the unit the content class would be designed to support, they reviewed the science standards for the subject area, and they reviewed and revised the facilitator’s plan for the class. Following the class, the facilitators and project leadership debriefed and revised the class as necessary. (Evaluator, elementary science LSC)
By the end of the program, the role of these teacher leaders had shifted away from primarily demonstration to a more multi-faceted classroom support role; thus, the name change to Resource Teacher. The Resource Teacher role still included demonstration lessons as well as planning with teachers, co-teaching lessons, observing and debriefing with a classroom teacher and working with grade level groups to plan and assess progress. The shift from Demonstration to Resource Teacher was discussed at length among project staff and, during meetings over the course of the final years of [the project], Resource Teachers reflected on the new roles they were assuming in support of teachers’ implementation of the curriculum. (Evaluator, K–12 mathematics LSC)

In year one, the role [of school-based teacher leaders] was more of a resource and coordinator at each school, as well as a team member on the science leadership team. However, project leaders found that many [teacher leaders] found this “job description” too vague and were inexperienced with designing their own professional development sessions to conduct for the teachers in their schools… In response, [project staff] reframed and designed a coherent, yearlong set of experiences for the [teacher leaders]. (Evaluator, elementary science LSC)

The personal and professional impact of these preparation activities was substantial. Said these individuals:

*My experiences as a science leader have definitely changed my teaching. I spend more time preparing my lessons and more time teaching science that I did before. I am much more concerned with asking better questions and reflecting on the lessons and evidence of student understanding.* (Teacher Leader, elementary science LSC)

*My experience with [the LSC] has elevated [me] to a higher level; it has empowered me to deliver the message that our district is moving ahead of the pack by implementing Trailblazers, and it’s our job to help those coming along behind us.”* (Teacher Leader, K–12 mathematics LSC)

*As a science leader, I was really forced to analyze my science curriculum and to be a good role model for others at my school…It has made me refocus on my teaching skills, classroom management, integration, and modeling. These are things I should always be aware of, but often become neglected over time. It was a motivator to improve myself as a teacher in general.* (Teacher Leader, elementary science LSC)

*I have changed the way I think about content. Math was monolithic for me—I had spent so much time struggling to make the traditional curriculum meaningful and compelling. Through IMP my sense of what content is important and makes sense to teach high school students have changed tremendously.* (Teacher Leader, secondary mathematics LSC)

Despite these testimonials, varying levels of experience, as well as turnover and reassignment, continue to challenge LSCs in their efforts to fully prepare teacher leaders. Content needs remain huge, particularly among elementary and middle school teacher leaders. Evaluator
reports suggest that LSCs increase their focus on content preparation for teacher leaders as projects mature. Even so, much of the focus is on module-based content, and is less likely to convey the “big” conceptual picture or link content across units—both critical needs in the eyes of LSC PIs. Developing teacher leaders’ understanding of, and capacity for, modeling and discussing inquiry-based instruction also continues to challenge LSCs. Said one evaluator: “While the project has made serious inroads into enhancing [teacher leaders’] content and pedagogy knowledge, the wide variety of competency continues to be of major concern.” Another evaluator agreed:

Concerns still remain regarding how the project identifies and addresses the differences in background among the project mentors. The training session focused principally on their kit familiarity and the logistics of the workshop session planning; again, because these are respected teachers in the region, it is assumed that they all have the background knowledge in content, pedagogy, and adult learning principles to implement their plan in a high-quality manner…Mentor training, as currently carried out by the project, does not identify and address the differing needs of the individuals in the mentor group. (Evaluator, elementary science LSC)

In reality, LSCs continue to face implementation and scale-up pressures that require teacher leaders to acquire their training “on-the-job.” This dilemma continues to be a major problem for many LSCs, resulting in professional development providers who are pressed into service prematurely. Said these evaluators:

We believe that among many of those providing professional development, there is a shared vision of high quality mathematics education and the professional development needed to achieve it. Similarly, we believe that many professional development providers understand the program goals, strategies, and needs of the participants…However, there are many professional development sessions being led by teachers and lead teachers who are less qualified and perhaps not in tune with [the project] goals. (Evaluator, secondary mathematics LSC)

Based on both our professional development observations and our teacher interviews, more attention is needed to develop the knowledge and the skills of the teacher leaders who are serving as the trainers in the introductory workshops…The training sessions for teacher leaders have been brief, about an hour in duration, and have tended to focus on the logistical and organizational issues of leading a kit training…An exacerbating factor this past year has been the demand on the project to scale up and serve increasing numbers of classroom teachers. In the past, only those teachers who had taught the kit at least twice were invited to serve as trainers, but with the high demand for kit trainings, those who had only taught once have been encouraged to step in and lead a workshop. (Evaluator, elementary science LSC)

The science facilitators attended numerous PD sessions that increased their own knowledge and learning, but they were not skilled in designing sessions that would help them share this new learning with their teachers. (Evaluator, elementary science LSC)
Teacher leaders still have a long way to go to internalize and be able to model and communicate this vision in their role as professional development providers. There was a wide range in the effectiveness of the seminars facilitated by the [LSC] lead teachers. (Evaluator, K–12 mathematics LSC)

The Challenge of Preparing Teacher Leaders

“At one small group session, designed to have grade level teachers reflect on students’ responses to a common performance assessment, the [lead teacher] was not able to keep participants focused on examining evidence of students’ conceptual understanding—perhaps lacking sufficient knowledge of, or experience with, performance tasks and scoring rubrics herself…Such facilitation work is especially delicate. It requires a depth of knowledge about science content, pedagogy, and the interpersonal expertise necessary for working with adult learners that many existing [lead teachers] have not yet acquired.” (Evaluator, elementary science LSC)

With many teacher leaders lacking the knowledge and skills needed to carry out their roles effectively, quality control remained an ongoing challenge. Co-facilitation of workshops and one-on-one support, particularly with school-based leaders, were highly recommended for ensuring quality. PIs also recommended a design that includes ongoing communication, consultation, observation, mentoring, and formative feedback. Few projects, however, have sufficient resources or staffing to monitor all of the professional development activities led by teacher leaders. Multi-district LSCs were especially challenged in this area; in some cases, LSC staff noted that they had a “general awareness” that professional development was being provided, but had “little direct input into the design or in the selection of providers.” Typically, LSCs relied on data from observations, self-reports from professional development providers, and workshop evaluations for monitoring quality. But some evaluators called for a more systematic approach:

What was missing throughout the previous two years was a systematic approach to articulating and communicating standards of effective professional development, and a mechanism or structure to assess and enhance teacher leader practices, and to provide opportunities for observing and reflecting on the quality of professional development practices implemented by teacher leaders in the context of the standards. (Evaluator, K–12 mathematics LSC)

The [Leadership Team meetings] represent a significant effort on the part of project staff intended to develop in-house providers of professional development and thus to ensure the continuation of the project after LSC funding is gone. However, it is important to note that, in general, there is no systematic mechanism for determining the qualifications of providers of professional development or for monitoring the quality of professional development being offered by the districts. (Evaluator, secondary mathematics LSC)

Evaluators also noted another dilemma encountered by LSCs in preparing teacher leaders: developing leadership skills balanced with efforts to improve capacity in the areas of content and
pedagogy. Clearly, both content and pedagogy are critical for improving teacher leaders’ own instruction, and their ability to work with their peers around the designated materials. However, in the interest of preparing teacher leaders in content and pedagogy, LSCs sometimes devoted limited time specifically to leadership development, thereby neglecting key skills needed for facilitation, coaching, and mentoring roles. Of the 442 professional development sessions observed for the core evaluation between 1998–2001, a total of 103 included teacher leaders as participants. Of the 48 sessions that were exclusively for teacher leaders, 29 included a focus on leadership, but only 14 (30 percent) dealt solely with leadership issues. As one evaluator noted: “It was challenging [for the LSC] to simultaneously provide teacher leaders with professional development that extended their mathematics content and pedagogical knowledge, and knowledge of equity issues in mathematics education at the same time as they were building leadership skills and learning about supporting teachers and families in the educational change process.”

**Support for Professional Development Providers**

The need for ongoing support is pronounced, given that professional development providers often assume project roles before they are sufficiently prepared. In the most effective cases, LSCs balanced workshops and institutes for providers with ongoing opportunities for reflection, problem-solving, and collegial interaction. Some projects involved teachers on special assignment and school-based teacher leaders in regular meetings to refine strategies and monitor progress. In one LSC, for example, monthly staff meetings helped improve communication among project mentors, and provided opportunities to discuss problems and devise solutions to implementation barriers—among them, teachers’ and administrators’ negative attitudes toward constructivist pedagogy.

Creating teams of veteran and less experienced professional development providers functioned as a primary support mechanism. Opportunities for co-planning, co-facilitation, and debriefing were, in the words of one evaluator, “for the explicit purpose of mentoring” facilitators to prepare them for conducting professional development sessions on their own. Still, this solution proved challenging where the numbers of teacher leaders were limited, as noted by this evaluator:

> Ongoing support for the next level of professional development providers, the teacher trainers, is not currently as strong or as multi-faceted [as for key professional development providers]. Teacher trainers do receive a “training kit,” which greatly supports them by having an already prepared and organized set of training materials. Also, as a support, the project tries to partner novice teacher trainers with a veteran trainer for each workshop. In reality, however, with the dearth of teacher leaders and the demands of scaling up the number of trainings, it is not always possible to form teams. (Evaluator, elementary science LSC)

Some projects promoted the development of sustainable “communities of learners” to develop a system of mutual support and to enhance teacher leaders’ appreciation and capacity for life-long learning. Other LSCs amended budgets, added administrative staff to assist teacher leaders, and
worked with districts to increase their level of support. LSCs also provided opportunities for
teacher leaders to participate in national workshops and conferences; although limited in the
numbers of teacher leaders they could send, these “support” opportunities were critical for
building capacity and for linking leaders to a larger community of learners.

LSCs that have been funded for a number of years manifest the benefits of working with a set of
professional development providers over time. Some have closely monitored providers’ needs,
refined tasks and roles, and provided continuing opportunities for providers to hone their vision
and skills. For example, in one project, “Alumni Institutes” for leaders who had already attended
core training provided additional opportunities to deepen knowledge and skills in content,
pedagogy, leadership, and facilitation. Another LSC developed an extensive, integrated system
for both preparing and supporting professional development providers, including formal and
informal meetings, institutes and conferences, co-teaching with peers, mentoring by core staff
and master teachers, study group research, and development of teaching “scripts” for workshops.

In contrast, other LSCs were less attentive to supporting professional development providers,
one the initial introductory sessions to vision, goals, and strategies had transpired early in the
life of the project. Both LSC staff and evaluators sometimes noted the lack of a deliberate and
comprehensive program of support, with embedded “structures or processes” to help providers
identify and tend to their needs in relation to LSC goals. Said these individuals:

*During the second year of the project, no formal preparation sessions were held for
presenters. The strategy has been to rely on the experience of the mentors and presenters
with the content, materials, and pedagogy.* (Evaluator, secondary mathematics LSC)

*[The project] plan did not develop a comprehensive or systemic structure for [teachers
on special assignment] to look at, evaluate, and stay current with research that supported
the kind of work we were being asked to do. [Teachers on special assignments’] own
understanding of the knowledge that supports professional development in what we know
about learners and learning in general, what is known about teachers and teaching, the
nature of the disciplines of mathematics and science, the principles of effective
professional development, and the knowledge about change and the change process
varied greatly. The mechanism for identifying what information we know and what we
need to learn to inform the work we were doing was not operationalized.* (Teacher on
Special Assignment, elementary science LSC)

*Project staff have great confidence in their identified leaders. Mechanisms to provide
explicit ongoing support for project mentors and content specialists are not evident in
project plans and strategies. Individuals who need assistance do contact project staff,
who are reported to be extremely responsive and helpful in addressing questions,
providing resources, or reviewing plans. Such support is reactive in nature, however.*
(Evaluator, elementary science LSC)

In short, LSCs have done much to support professional development providers, particularly
teachers on special assignment, but there remains a great deal of room for improvement. Both
PIs and evaluators noted that capacity-building takes place in incremental steps. It requires
support mechanisms, a long-range plan, and deliberate strategies for monitoring needs and developing skills to allow professional development providers to increase their competence over time.
HIGHLIGHTS: Professional Development Providers

STRENGTHS

Teachers on special assignment continue to play significant roles as professional development providers, bringing a wealth of experience to the LSCs and credibility among classroom teachers.

LSCs use teaming strategies for achieving a balance among professional development providers—matching less experienced leaders with core staff and teachers on special assignment, and content experts with classroom-savvy teacher leaders.

LSCs have looked for ways to better communicate vision and expand the roles of professional development providers through involvement in project planning, activities specifically designed to reinforce the LSC vision, and mentoring opportunities.

LSCs have sought to build a community of learners among teacher leaders to support ongoing discourse and reflection on content and pedagogy.

CHALLENGES

The diversity of background and level of preparation among professional development providers continues to have implications for the quality of LSC professional development.

Teacher leaders require time to learn, practice, and reflect on new instructional practices before they can effectively help others; yet, out of necessity, LSCs continue to “press” these leaders into action before they are sufficiently prepared.

LSCs concentrate on preparing teacher leaders in content, pedagogy, and materials, but focus significantly less time on developing leadership and facilitation skills needed to mentor, coach, and work with adult learners.

LSCs continue to struggle with building vision and communicating roles to professional development providers, and with developing a strategic long-term plan for assessing providers’ needs, monitoring quality, and providing ongoing support.
Creating a Culture Conducive to Teacher Learning

- Building an Atmosphere of Trust, Respect, and Openness to Ideas
- Providing Opportunities for Shared Dialogue, Collaboration, and Reflection
- Teachers’ Views about Participation and Relevance of Professional Development

High quality professional development requires a culture in which teachers feel comfortable sharing ideas, exposing weaknesses, collaborating with both facilitators and peers, and openly reflecting on issues related to teaching and learning. This model contrasts markedly with traditional professional development activities familiar to most teachers. At times, these disparities caused tensions—when teacher expectations for “make and take” sessions conflicted with the LSCs’ efforts to model an inquiry-oriented approach.

Based on evaluators’ observations, LSCs were highly adept at creating a professional development culture in which trust, risk-taking, and collaboration prevailed. The majority of projects described in evaluation reports revealed a culture highly conducive to teacher learning.\(^5\) (See Figure 1.) The following section looks at the ways in which LSCs created a professional development culture that encouraged teachers to be both learners and reflective practitioners.

\[^5\] Evaluators used a five-point scale to rate the extent to which the professional development culture encouraged teachers to be both learners and reflective practitioners, where 1 was “inhibited effective professional development” and 5 was “facilitated effective professional development.”

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Figure 1
Building an Atmosphere of Trust, Respect, and Openness to Ideas

From the evaluators’ perspective, LSCs excelled at treating participants as adult learners and professionals—critical for instilling a sense of mutual respect. In large part, using former teachers as professional development providers contributed to this achievement: teachers on special assignment were typically strong in creating a collegial atmosphere in which participants’ own knowledge and background were valued part of the conversation.

LSCs used a range of formats to promote an “open” atmosphere characterized by trust and respect, including small group discussion, collaborative problem solving, and reflection around student work and personal classroom experiences. For example, in summer institutes in one project, teachers were asked to reflect on specific questions, write their responses in their journals, and then participate in a facilitated discussion around those reflections. The evaluator reported that such discussions resulted in a highly collegial learning environment for participants—one in which all perspectives and comments were valued. Similarly, an evaluator in another LSC described a culture that was both dynamic and collaborative:

The culture of this session was excellent. The facilitator made use of the round robin structure—a structured way of taking turns—to make sure that everyone had a chance to share. Participants shared throughout and did not seem to feel that they had to reach agreement on issues they discussed; however, they were asked to back up their statements with evidence and explanations. They reflected and shared their observations with the group. Participants listened to each other. The feeling of the session was supportive and focused. (Evaluator, elementary science LSC)

Evaluators report that, for the most part, professional development providers were sensitive to participants’ needs and encouraged active participation. In their roles as facilitators, current or former teachers are acutely aware of the needs, concerns, and barriers faced by classroom teachers; their intimate understanding of these issues “personalizes” the professional development for participants. Encouraged to ask questions and acknowledge their weaknesses, teachers “didn’t feel bad [if they] didn’t know something.” In some cases, teachers’ prior experiences in non-LSC professional development had been marred by “college and university professors [who were] distant, too theoretical/impractical, and condescending.” In contrast, LSC sessions were “of, for, and by teachers.” In the words of one teacher: “It didn’t matter if you were a beginning teacher or one with a lot of experience, you were able to fit right in with the entire group and you were treated as an equal.” Said these evaluators:

The atmosphere was open and encouraging. Even the least experienced teachers or the least-math savvy teachers were made to feel welcome and were not intimidated to speak and present ideas. The facilitators made a point of discussing the differences between the middle and high school teachers in their problem solving approaches, while pointing out the virtues of each. (Evaluator, secondary mathematics LSC)

[The] PD facilitator created a collaborative culture despite teachers’ hesitancy to critique one another’s work. Facilitator modeled “not knowing” why one investigator’s results proved perplexing; encouraged the group to work together to consider what may
have gone wrong; to pose steps for further investigation. (Evaluator, elementary science LSC)

The morning session went well with the facilitators monitoring the participants for direction. There were some wonderful discussions about the different things teachers had been doing over the past several months around assessing students or reflecting on their own practice. There was also a discussion that went into questioning as it applied to assessment and what students learned or knew. (Evaluator, elementary science LSC)

LSCs also encountered some culture-related challenges—for example, in creating a “comfortable” atmosphere in professional development sessions, yet one that also stretched teachers’ knowledge and beliefs. In addition, teacher leaders sometimes fell into “familiar patterns of communication,” such as provider-directed discussions which precluded a sharing of ideas. Reported one evaluator: “Although most professional development facilitators focused on developing a learning community, the quality of facilitation varied across sessions, as in previous years. In one observed professional development [session], for example, the facilitator directed the discussion in ways that seemed unresponsive to teachers’ needs, which seemed to alienate some participants.”

Scientists/mathematicians who led content sessions ran a similar risk. For example, in describing sessions facilitated by industry scientists, one evaluator noted, “Most often, the scientist talked and participants listened and responded.” In these cases, evaluators suggested that the lack of preparation for professional development providers—both teacher leaders and content experts—may have contributed to a less “open-ended” approach.

Providing Opportunities for Shared Dialogue, Collaboration, and Reflection

By “design and necessity,” LSC professional development sessions typically reflect a culture that promotes collaborative work—one that is the “antithesis” of participants’ daily experiences in the classroom. Said one teacher: “An aspect [of the workshop] that made a great impression on me is the interaction and sharing that took place. Our profession is designed where we go into our rooms, do our job, and have very little opportunity to share ideas and methods with other educators in the same grade.” A teacher from another LSC made a similar comment: “I was with other teachers, hearing about what they had done, instead of just figuring out what to do on my own all the time.”

LSCs typically structure professional development activities in ways that promote dialogue and a joint sense of purpose—where all participants are encouraged to contribute. In larger group settings, staff developers created a seminar-like atmosphere in breakout sessions where diverse participants—teachers of different grade levels, teachers and administrators, teachers and parents—collaborated as learners and reflective practitioners. Study groups, kit clubs, and debriefing sessions provided similar kinds of opportunities. Evaluators provided numerous examples of sessions which encouraged this kind of interaction, as described below:
During the afternoon, all members of the group were actively engaged and contributed to the discussion. They asked thoughtful questions. The trainer listened carefully to the group members. She struck a comfortable balance between presenting the materials she needed to share with the group and allowing enough latitude for the group to fit the information to their needs. (Evaluator, elementary science LSC)

The major evidence in this session, beside the clearly equitable and positive culture which the facilitators developed, was the fact that both facilitators were bilingual education teachers of science and were themselves minority females. They used examples and made connections, which reflected their personal understanding and insights into diversity...Every aspect of the session facilitated engagement, invited participation, helped all reflect on the importance of each aspect of the sessions, and definitely modeled the facilitation of a learning community atmosphere. (Evaluator, elementary science LSC)

The Teacher Institutes are designed to create a classroom-like atmosphere where participating teachers work together as both learners and reflective practitioners. The content and assessment stretch the teachers’ personal knowledge of mathematics at the same time that they cause teachers to work collaboratively on strategies for including new insights into their classroom practices...The culture promoted in the institutes is, by design and necessity, open to shared dialogue and collaboration. (Evaluator, elementary mathematics LSC)

Sessions are designed so that a major portion of time is spent in small group work. As teachers work their way through curricular materials, they work together to solve problems, discuss pedagogy, and share their own experiences in implementing mathematical curricula in their classrooms. (Evaluator, secondary mathematics LSC)

### Teacher Feedback on Opportunities for Shared Dialogue

Participant feedback on evaluation forms indicates a high level of shared dialogue and collaboration in LSC professional development. For example, when asked about the most helpful aspect of the professional development, 29 percent of the teachers noted that collaborating/networking with other teachers has been the most helpful aspect of the LSC. The following comments were typical:

- Sharing ideas with other teachers and working together.
- Discussing the successes and failures people are encountering implementing this curriculum.
- Being able to discuss concerns and ways to address them.
- Communicating and sharing between grade levels.

In creating opportunities for collaboration, professional development providers experienced challenges not unlike those of the typical classroom teacher: balancing the needs of participants
(and allowing enough time for discussion and reflection), with the need to cover content and pedagogical issues. As one evaluator explained:

*There is extensive sharing among participants and between participants and facilitators. At times, participants wanted to continue sharing and they were moved on to the next part of the sessions by the facilitators. Balancing the need to allow “sharing” and the need to meet the workshop goals is a delicate art, given the limited training time and extensive need. At times, participants indicated that they felt “rushed,” but the overall tone of the observed sessions was one of mutual work and respect.* (Evaluator, elementary science LSC)

Evaluators also provided examples in which LSCs had designed sessions to foster collaboration and dialogue, but the implementation of these designs by inexperienced professional development providers was somewhat flawed. The result was a lack of rigor in discussions, which focused on logistical issues rather than on those related to teaching and learning. Noted these evaluators:

*We have seen that the professional events do indeed offer designs which are intended to promote reflection and discussion, but we have not seen great evidence of animated, engaging conversation among teachers. Rather, in general, we have seen that teachers have had a difficult time conversing with a focus on instructional issues, and simultaneously, the professional development providers have been challenged to encourage these discussions. Thus, the implementation of the design has been problematic…[The project] has been very successful in establishing a culture where all are welcomed and included. However, now in its third year, we feel the next developmental step is to devise ways to create a more rigorous and intellectual culture, where teachers can learn to become more reflective practitioners.* (Evaluator, elementary science LSC)

*The weakest link in the professional development is the wrap-up and reflective portions of the sessions. Generally, participants were not given sufficient time to reflect on their practice. The breakout sessions were often cut short because of time constraints and a lack of skill on the part of the facilitators to lead discussions that involved all the participants.* (Evaluator, elementary mathematics LSC)

As for the [study group] sessions, observations noted inconsistencies in the extent to which time was allotted for participant sharing. This appeared to be a function of who was facilitating the sessions, as well as the number of teachers who attended… Furthermore, the sharing tended to focus on implementation issues (logistics, management, problems with individual lessons). In general, the project is still struggling with how to move teachers beyond “surface” level discussions of the kits and into deeper reflection on their teaching practices. (Evaluator, elementary science LSC)

In short, facilitating meaningful dialogue and reflection requires a level of skill that many providers lack—a “fine art” developed over time. Sometimes facilitators were overeager to speak from their own experience, instead of eliciting the experiences of participants. In addition,
providing opportunities for rigorous dialogue and discussion sometimes went against the prevailing culture. Said this evaluator of the dilemmas faced by LSCs: “The tension between maintaining a comfortable culture, and allowing participants the time for reflection and intellectual discussion of ideas is a challenge for the project, as it is for many LSCs. It appears that the culture of the district and perhaps even the town places great emphasis on maintaining a level of comfort and acceptance that, at times, reinforces the status quo, making efforts at change a bit difficult.”

Teachers’ Views about Participation and Relevance of Professional Development

The majority of evaluators reported high levels of enthusiasm from participants in LSC professional development activities. To some extent, the “voluntary nature” of many LSC sessions virtually ensures “eager” participants. Some LSCs struggled to keep up with requests from schools and the demand for workshops, with sessions filled to capacity and beyond due to word-of-mouth advertising. At the same time, projects have encountered quite a few resistant teachers—for example, those in later cohorts who have been more likely to resent expectations for participation. In some cases, the “LSC culture” that fosters respect and collegiality effectively won over these resisters. Said one evaluator: “Even the third cohort of teachers participating in the project for the first time, who may have been characterized as ‘reluctant’ at the outset, were mostly enthusiastic at the end of the institutes.”

Teachers’ views about participation were also shaped by their perceptions of the relevance of LSC professional development and the responsiveness of providers in meeting their needs. Some projects presented the LSC vision in light of state standards, assessments, and competing priorities in order to address teachers’ immediate concerns in these areas. In one project, for example, the LSC linked student success in English language acquisition with science instruction, thereby enabling teachers to address the state and district emphasis on literacy while also improving science instruction; as a result, teachers perceived the LSC reforms as enormously relevant, and participation in summer sessions was high.

Other LSCs designed courses and workshops directly around the district’s core curriculum. As one evaluator noted, content knowledge was addressed, “not as a discrete topic, but in the context of the teachers’ own exploration and investigations of the IMP curriculum. [This] had two significant implications: the mathematics content was worthwhile, and it was presented in a ‘need to know’ context that was directly motivated by teachers’ need to apply their content knowledge immediately to their classroom instruction.” Participants also reported finding LSC sessions to be practical, rigorous, and relevant to their world, as these teachers note:

*They aren’t just cute little activities to keep busy. We are doing science and we have a scientist to validate that and to help us with the process. This is real science and we are asking real questions… This is not just a bunch of fluff and cutting things out and gluing them together.* (Teacher, elementary science LSC)
All professional development was in some way related to the use of the instructional materials. As a result, there were few questions from teachers about “what does this mean for my classroom?” (Teacher, K–12 mathematics LSC)

These workshops have been very valuable because they are so relevant to what I do everyday. As a teacher, I seldom have opportunities to observe others actually conducting a lesson. Watching and analyzing these videos gives me a chance to think about my own work. (Teacher, secondary mathematics LSC)

In some cases, teachers reported an evolving greater willingness to attend professional development activities, and a greater awareness of the intrinsic rewards for participation. Said this elementary teacher—in the Final Year of the LSC—about how the culture had spilled over into school practices: “Teachers who have been afraid of teaching science are teaching it. No one on the [school science] committee is offended by science evaluation. We now talk non-judgmentally about each other. We bring samples of a lesson into the lunchroom to show [one another].”

Still, logistical issues sometimes affected teachers’ attitudes toward participation—for example, the amount of time involved in planning and setting up LSC classroom activities, grading alternative assessments, and attending professional development sessions that competed with other school demands. Evaluators reported that LSCs encountered particular difficulties with secondary level teachers who were more reluctant to participate and/or to recognize the need for change. For example, high school teachers noted “familiar themes” in their criticism of LSC materials: “fuzzy math,” too little emphasis on computation, too much group work, and so on. Some teachers saw the LSC as prescriptive and top-down, placing limitations on their creativity. Others believed LSC materials and methods were “too advanced” for their “high-risk” students. Finally, contextual barriers—scheduling conflicts, school climate, lack of administrative support, testing—influenced both elementary and secondary teachers’ attitudes toward participating, and their eagerness to embrace new strategies and materials.
HIGHLIGHTS: Creating a Culture Conducive to Teacher Learning

STRENGTHS
LSCs excel at creating a professional development culture that promotes trust, respect, and openness to risk-taking—a culture in which teachers feel the full benefits of being treated as professionals.

LSCs deliberately structure professional development activities to promote collaboration, collegial discussion, and reflection; these opportunities are highly valued by teachers who typically operate in “isolation” in their jobs.

LSCs have made professional development offerings highly relevant to the work of teachers—with practical and direct applications in the classroom—and these efforts have resulted in positive teacher attitudes about participation.

CHALLENGES
LSCs have found it difficult to develop a culture in which teachers feel comfortable, yet one that is also rigorous and stretches the limits of their knowledge.

Professional development providers sometimes struggle against “old habits”—reverting to approaches that inhibited teachers’ participation as active learners.

LSCs have sought to find a balance—providing enough time for discourse to engage teachers and address interests and needs, while also allowing sufficient time to address important content and pedagogy, as well as instructional materials.

Contextual barriers and entrenched attitudes, particularly at the secondary level, influenced teachers’ views about the relevance and value of professional development activities.
Professional Development Programs

- Deepening Teachers’ Content Knowledge
- Enhancing Teachers’ Pedagogy and Use of Exemplary Materials
- Support for Teachers During Implementation
- Strategies to Ensure Participation

Though LSC projects range widely in their designs for professional development, all are guided by the central goal of improving classroom instruction in mathematics/science. To do so, project leaders must strengthen teachers’ content knowledge, pedagogical skills, and ability to use inquiry-based materials. The LSC professional development programs evaluators considered most effective reflected a design that was “conceptualized and implemented as an overall program of work, not as a laundry list of offerings,” where providers communicated to participants that “how to teach using the instructional materials is as important as what is being taught.”

LSCs have acted on the premise that content and pedagogy are most accessible when learned in the context of student instructional materials. Such an approach requires a finely tuned balance in the presentation of content, pedagogy, and materials—where content is “not sacrificed,” where new practices are both modeled and explicitly discussed, and where teachers have opportunities to reflect on new practices. In practice, the balance scale favored pedagogy and materials: across all LSC projects, 78 percent of the observed professional development sessions included a focus on familiarizing teachers with LSC-designated materials and/or pedagogy, while only 42 percent of the observed sessions included a focus on increasing the mathematics/science content knowledge of participants. The heavier emphasis on pedagogy/materials over content is seen across Baseline Year, Year Two, and Final Year projects. (See Table 1.)

The following section looks at various aspects of LSC professional development activities: deepening teachers’ content knowledge, pedagogical skills, and use of exemplary materials, and LSC efforts to support teachers during implementation and ensure their participation.

### Table 1

LSC Professional Development Sessions

<table>
<thead>
<tr>
<th>Observed Including a Focus on Pedagogy and Content</th>
<th>Percent of Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Baseline Year</td>
</tr>
<tr>
<td>Pedagogy/Instructional Materials</td>
<td>78</td>
</tr>
<tr>
<td>Content</td>
<td>42</td>
</tr>
</tbody>
</table>

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6 Of the 442 professional development sessions observed by evaluators, eight percent focused exclusively on content, while 31 percent focused exclusively on instructional materials/pedagogy.
Deepening Teachers’ Content Knowledge

- Attention to Content and Key Concepts: Module-Based and Beyond
- Accuracy and Accessibility of Content for Participants
- Meeting Teachers’ Content Needs

LSCs concur that teachers have vast needs in content, particularly at the elementary level. Despite this “common knowledge,” projects range widely in the level of emphasis they place on content in professional development activities. For example, an evaluator in one project estimated that approximately 90 percent of the professional development was “content-rich,” while the evaluator of another project reported that content was the “least emphasized aspect of the professional development.” In their efforts to make content “palatable,” LSCs typically teach it “through process, much as a student would experience it in the classroom.” This approach often made it difficult for LSC staff and evaluators to delineate the emphasis on content when “the medium [the materials] was part of the message.” Aside from the quantity of content offered in LSC professional development, evaluator ratings of the quality of treatment of disciplinary content suggest that LSCs continue to encounter some challenges in this arena. While the majority of projects received a rating of 4 or 5, 41 percent were rated 3 or lower, indicating some weaknesses that may have limited the effectiveness of the professional development.⁷ (See Figure 2.)

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⁷ Evaluators rated sessions on a five-point scale, where 1 was “poor” and 5 was “excellent.”
Attention to Content and Key Concepts: Module-Based and Beyond

Evaluators consistently noted that LSCs continue to place a high level of emphasis on module-specific content in summer institutes prior to teachers’ implementation of the materials. Overall, evaluators found this to be a sensible approach. Said one: “Given the concerns of new users of kit-based programs—‘What’s in the kit and what do I do with it?’—this level of emphasis is reasonable.”

Evaluators also reported that, on the whole, content was well integrated throughout the design—through summer workshops and school-year, follow-up activities. For example, in one LSC a wide array of opportunities for deepening content knowledge occurred through: (a) site-based and cross-district workshops; (b) curriculum workshops focused on teacher content needs and local standards; (c) university-based content courses taught by faculty and master teachers; (d) an individualized mentor program for new teachers; (e) summer institutes; and (f) monthly after-school meetings. Other LSCs used workshops focused on assessment and student work to better integrate content across professional development opportunities; for example, assessment institutes in some projects helped teachers make connections among key concepts and learn appropriate ways to determine students’ level of understanding.

While questionnaire data suggest that the emphasis on content remains fairly stable over the course of the LSC, evaluators noted cases in which LSCs have increased the level of attention to content in professional development. The shift has occurred as teachers began to recognize their deficits and demand more content-based sessions, and as core staff came to realize that the amount of time initially devoted to content was inadequate. Some LSCs altered introductory institutes to incorporate more content, matched to state and national standards. Others developed mini-courses, and increased the number of after-school meetings to address module content, using university faculty to “translate concepts into thematic applications.” Still others used classroom videos in small group sessions for in-depth content analysis, or sought to bridge concepts across modules and grade levels. Some university-designed courses went well beyond the student materials to the in-depth study of particular disciplines.

Both the level of emphasis on content, and the effective communication of key concepts, were often dependent on the capacity and skills of the professional development providers. Content experts increased opportunities for teachers to “make conceptual connections,” and fostered more rigorous, intellectually engaging sessions with both depth and breadth of coverage. Evaluators also cited examples in which teachers on special assignment facilitated effective sessions, using the instructional materials to deepen teachers’ conceptual understanding. For example:

In the workshop, the content followed the IMP structure of developing concepts by building from one concept to another. The facilitator was meticulous about asking teachers to prove and justify their solutions and approaches, and ensuring that there was mathematical accuracy in their presentations and discussions. The facilitator constantly challenged participants to come up with other approaches and ideas and asked questions that prompted teachers [to do so]. This technique created ongoing mathematics discourse among participants and between facilitator and participants. When a group of teachers was quicker to grasp a solution to a problem, the facilitator challenged them
with a question or another problem which gave them opportunities to develop their thinking further.  (Evaluator, secondary mathematics LSC)

Observations by evaluators also pointed to some weaknesses among professional development providers. In numerous cases, evaluators described facilitators who were less adept at deepening content, or making conceptual connections. Said these evaluators:

The facilitator either lacked confidence or did not know the scientific concepts underlying the lessons and rather than present inaccurate information, chose to avoid discussing it. When the teachers questioned her about the concepts, and showed they wanted to talk about content, the facilitator changed the subject and moved the discussion in the direction she felt most comfortable—giving teachers tips and strategies for managing their classrooms while doing the module investigations. (Evaluator, elementary science LSC)

The exploration of mathematics content was not included in any systematic way in the design or implementation of the professional development activities provided by teacher leaders. The teacher leaders tended to make assumptions about the level and extent of their colleagues’ content knowledge, [and were] unwilling to provide opportunities for teachers to do mathematics investigations or to probe participants’ content understanding. (Evaluator, K–12 mathematics LSC)

As the number of teacher leaders, especially less experienced teacher leaders, has increased, so has the quality of the presentation of these complex elements of the workshop diminished. The reason for this is because these workshops are so dependent on a facilitator’s skill, as well as their content knowledge. In most of the introductory workshops we have observed, the “big idea” is referred to only briefly at the beginning of the workshop, and then has been neglected for the rest of the session. (Evaluator, elementary science LSC)

LSCs encountered other difficulties in their efforts to increase opportunities for content enhancement. For example, elementary teachers who clamored for more professional development focused on content wanted “immediate applications,” as opposed to “deeper” content that they perceived as unrelated to the student materials. As a result, professional development sessions designed to provide teachers with opportunities to examine their own practices in light of content deficiencies often focused on logistics and classroom management issues, as opposed to increasing content knowledge.

In response to these observations, evaluators noted the need for LSCs to broaden their approach to deepening teachers’ content knowledge—beyond simply providing an array of module-specific content delivered through the completion of activities. Some suggested that LSCs focus greater attention on developing a “storyline,” in which the “big ideas” are clearly articulated and revisited over time to develop teachers’ conceptual knowledge—in specific modules, across modules, and beyond the materials altogether.
Accuracy and Accessibility of Content for Participants

For the most part, evaluators reported that the content presented in professional development sessions they observed was accurate and accessible. LSCs’ use of teams of teacher leaders and scientists/mathematicians greatly enhanced capacity in this area. When well prepared for their roles, content experts made strong contributions to the quality of content-focused professional development.

In introductory workshops in particular, content experts and other professional development providers were careful to present content in ways that did not alienate teachers who had limited mathematics and/or science background. Typically, providers ensured that content was accessible to teachers by embedding it in module activities or in discussions related to a specific activity—presenting it in “deliberately soft ways.” Said this evaluator: “The content specialists, as practicing scientists, were usually restrained in avoiding overwhelming teachers with complexity or detail. Rather than lecture, they typically tied content discussions to activities using simple materials.”

Given LSCs’ desire to build on teachers’ existing conceptual understanding and not “overwhelm” them, this approach makes sense. But professional development providers also ran the risk of not challenging participants enough in the area of content. Said this evaluator: “While ideas were shared freely, observers noted several instances in which the ideas were not challenged or pushed deeply, although the opportunity existed.” This was particularly true in activities led by teacher leaders, many of whom were just getting comfortable with the content themselves.

Evaluators also reported some variability in the effectiveness of content specialists in module training sessions. Some rushed through content in order to provide teachers with “maximum exposure.” The resulting pace, with little discussion and reflection, sometimes left teachers with a limited understanding of the content presented and the implications for their teaching. In other cases, content experts presented topics that were inappropriate for the participants—beyond their backgrounds and/or without clear links to the student materials. While the intent may have been to incite interest among participants, the end result was a missed opportunity for presenting the content teachers needed most. Other content specialists were reticent in their efforts to engage teachers in content, indicating some confusion about their role in co-facilitating sessions. Said these evaluators:

*It was apparent that the math consultant lacked clarity about her role and the issue needed to be addressed project-wide. There was little evidence that there had been any collaboration or prior discussion between the teacher [leader] and consultant in planning or preparing the session...The math consultant seemed reluctant to engage with teachers to focus their attention on the mathematics...and did not address the need to relate the mathematics in the software to teachers’ understanding and thinking about the key concepts of middle school mathematics, or to the concepts they were teaching from the designated materials.* (Evaluator, secondary mathematics LSC)

*The content specialist provided an interesting and understandable presentation on solutions, mixtures and suspensions, [but] participants were not likely to apply what they...*
learned because the presentation was not explicitly related to the activities they had just completed or to what followed. (Evaluator, elementary science, LSC)

These and other examples provided by evaluators pointed to areas that professional development providers struggled with: conveying conceptual understanding beyond module-based content, presenting content at appropriate levels, and making explicit content connections. Without these connections, teachers may not understand how the content applies to their lessons, or the ways in which they can use the information to build student understanding.

**Meeting Teachers’ Content Needs**

Given that the majority of LSCs do not require teacher participation, ensuring that projects meet teachers’ content needs presented a major challenge. The task required LSCs to design professional development that teachers perceived as interesting, relevant, and accessible, with a range of formats geared to varying participant content backgrounds. To meet these perceived needs, particularly in projects that did not adopt a single set of instructional materials, some LSCs chose to examine content in light of standards, frameworks, and student learning outcomes. Others opted for the “logistical progression” in meeting needs—first, helping teachers become comfortable with module activities, and then focusing on deepening teachers’ understanding of key concepts through the in-depth analysis of student work or through advanced sessions on concept development, team-taught by content experts and teacher leaders.

Courses at local colleges and universities, topic-specific workshops, summer institutes, seminars and symposia, and after-school and Saturday sessions were among the other strategies used by LSCs to meet teachers’ content needs.

LSCs made efforts to gauge teachers’ content needs in a number of ways. While a few evaluators described the use of teacher performance assessments and pre-/post-workshop instruments to track teachers’ content needs, projects typically relied on classroom observations by LSC staff, teacher leaders, and principals, and data from workshop evaluations, interviews, focus groups, and surveys. Content sessions were often designed in direct response to teachers’ oral and written feedback. For example, in an elementary mathematics project, staff realized that teachers were having difficulty identifying the algebra embedded in the mathematics materials, and responded by adding an “algebra strand” workshop and conducting post-session interviews to help gauge the usefulness of the sessions for meeting teacher content needs.

LSCs typically viewed small-group, follow-up activities as prime opportunities for addressing teacher content needs. For example, one LSC developed an entire “thread” of small-group sessions around content: unit-based, grade-level study groups that focused on student work; day-long, multi-grade group sessions led by mathematicians that developed a single topic across grade levels; and follow-up meetings led by teacher leaders that revisited the topic during implementation. In other LSCs, school teams provided an opportunity for those with stronger content backgrounds to support those who were weak in particular areas.

Still, the barriers to meeting teachers’ content needs were vast. As noted earlier, teacher leaders were often ill-prepared themselves in content, which hindered their efforts to meet the needs of their colleagues. Further, the use of study groups to deepen content background requires highly skilled facilitators, and many LSCs found it difficult to supply these in the quantities needed.
And while LSCs sought to assess and meet needs, project leaders were hard-pressed to make sure that teachers who needed disciplinary content received sufficient training. Rather, the primary strategies for ensuring that LSCs met content needs were indirect: increase teachers’ awareness of their content deficits, and provide appealing opportunities for professional growth. Said these evaluators:

_The [LSC] has learned that if you build good professional development programs, teachers will come…and voluntarily take advantage of opportunities to learn and to improve their teaching—if the opportunities are seen as worthwhile._ (Evaluator, elementary mathematics/science LSC)

_Like any other LSC, the [project] cannot and does not ensure that elementary teachers who need disciplinary content get it. The magnitude of the needs in this dimension are simply too great. [The project] does, however, substantially increase the opportunities for elementary teachers to improve their science content knowledge [with] a developmental professional development program that is organized, hierarchically, beginning with level one mandatory kit trainings, and progressing increasingly to challenging, science-focused offerings that are available to interested teachers._ (Evaluator, elementary science LSC)

_Is it reasonable to assume that a professional development program, no matter how systemic it is, can bridge all of the gaps in content knowledge that teachers might have? The answer is probably not. What this project has accomplished in the comparatively short time it has been in existence, however, is raising the level of awareness among teachers of what content is important to teach._ (Evaluator, elementary science LSC)

_Assessing content knowledge of participants was largely an informal process, although teachers were asked at end-of-session evaluations about their understanding of mathematical content. Project directors and teacher leaders have been in close contact with participants throughout the project and have come to know teachers well. This has enabled facilitators to “get a feel” for how well teachers understand the mathematics. However, no formal “testing” of teachers was done._ (Evaluator, elementary mathematics LSC)

Content continues to be a “hard sell” at the high school level, where teachers believe they have adequate command of the material, but attracting elementary teachers was sometimes equally challenging. Some evaluators reported that teachers typically did not ask for content support during the school year, and were more apt to use small group sessions designed to deepen content knowledge as opportunities to talk about topics other than content—logistics, planning, and pedagogy. Finally, teacher demands for in-depth treatment of a particular area of content were sometimes dampened by state expectations for breadth of coverage.

LSCs themselves face similar challenges: breadth of content coverage with a large number of teachers, versus depth of coverage for a few. While evaluators noted the improved capacity of LSCs to provide content needed by teachers, they also commented on the inherent limitations of the systemic approach: workshops reached the “breadth of the teaching force,” yet content
coverage was inadequate. University coursework provided in-depth content coverage, but reached only a “handful” of teachers. The dilemma prompted one evaluator of an ending K–8 mathematics/science LSC to say: “While the capacity of the project from 1995–2001 to deliver quality disciplinary content has been high, the quantity of the sessions offered could not address the needs of a large school system in deepening content knowledge…Deepening content knowledge of the teaching force remains nearly as large an issue at the end of the LSC project as it did at the beginning.”

Enhancing Teachers’ Pedagogy and Use of Exemplary Materials

- Exploring Instructional Materials
- Attention to Pedagogy
- Getting the Message Across: Modeling and Discussion of Effective Teaching Strategies

The emphasis on pedagogy and materials remains high in LSCs, and with few exceptions, the designated instructional materials are the “centerpiece” of professional development efforts. In addition to familiarizing teachers with the modules, however, LSCs must enable teachers to use instructional practices aligned with the materials—for example, inquiry and small group learning. In the best cases, professional development providers model these practices and make explicit connections to classroom applications. As noted earlier, LSCs give more attention to pedagogy and materials in professional development, with three-quarters of the observed sessions including these topics. Evaluator ratings suggest high quality in the projects’ treatment of pedagogical content, with about 80 percent of the projects rated 4 or 5, where 5 equals excellent. (See Figure 3.)

![Evaluator Ratings of the Quality of Treatment of Instructional Materials and Pedagogy](image)

*Figure 3*
Exploring Instructional Materials
A primary goal of LSC projects is to improve mathematics and science instruction through the use of exemplary materials in the classroom. With this overriding goal in mind, the vast majority of LSCs focus substantial time and effort on familiarizing teachers with the designated instructional materials. First and foremost, professional development sessions provide opportunities for exploring the materials that teachers will use in their classes. Teachers’ responses about the benefits of participating in professional development often boil down to this: “We learn how to use the kits.” In most LSCs, teachers have opportunities to explore the materials during summer workshops, and participate in follow-up sessions during the year to delve into the materials in greater depth.

As noted earlier, LSCs continue to place a high emphasis on familiarizing teachers with the instructional materials, given teachers’ immediate concerns for using the modules in their classes. Typically, teachers “experience” the activities as students might—working through problems in small groups—with guided discussions facilitated by core project staff, teacher leaders or content experts. Said these individuals about the focus on instructional materials in LSC professional development:

*Helping teachers become familiar with the modules designated for their grade levels is the predominant emphasis in the projects’ professional development design. Those activities that do not focus explicitly on learning to use the kits typically feature kit implementation as a vehicle for achieving other (content or pedagogy-related) purposes. This is not a negative feature. The prevailing culture in most of the target schools does not give high priority to deep reflection and discourse on teachers’ beliefs, knowledge, and practices...By framing professional development around kit implementation, the project is taking advantage of an existing “hook” to attract participation...[and] to use the implementation as a context for examining content and pedagogy.* (Evaluator, elementary science LSC)

*Little time in these introductory kit workshops is spent exploring pedagogy, how students learn, the needs of diverse learners or assessment strategies. This is, to some extent, by design. The goal of the introductory workshops is to get the teachers using the newly adopted science kits in their classrooms.* (Evaluator, elementary science LSC)

*It has been very helpful to be able to work through the materials before we taught it, to have us guided through [the units] rather than having to sort through the materials ourselves by those who taught this before...[We got] a lot of hints as to where kids stumbled and had problems...It alerted us to where our own kids might have problems...areas where we might want to plan on spending more time.* (Teacher, K–12 mathematics LSC)

That said, introductory training sessions can “afford” to (and, given context and culture, may be compelled to) take this approach. But the design also requires some trade-offs by LSCs. The emphasis on exploring materials may limit teachers’ initial awareness of the “big picture” (e.g., how the specific activities fit into a conceptual framework), and preclude deeper reflection on
specific pedagogical strategies. Noted one evaluator: “Teachers need more emphasis on how students learn, not just practice with materials.”

**Attention to Pedagogy**

Evaluators noted that understanding of pedagogy was an “important by-product” of sessions focused solely on student instructional materials—acquired by teachers only as they have gotten comfortable with the module activities, materials management and logistics, and the “overall progression of the unit.” As teachers become more conversant with the materials, LSCs have broadened the focus of subsequent professional development sessions, addressing pedagogical issues at a deeper level. Some projects integrate an “overview” into introductory sessions, while others have felt the need to create separate “vision workshops” to provide a broader “pedagogical orientation.”

The use of tiered professional development offerings has enabled LSCs to apply the same kind of developmental approach with pedagogy as used for deepening content knowledge. In the early stages, LSCs focus on materials familiarity, and the “overarching themes of teaching for understanding and assessment in service of student learning.” As teachers move beyond introductory sessions, evaluators noted that more advanced, “second level” professional development activities give greater emphasis to inquiry, constructivism, student thinking and learning, the needs of diverse learners, and assessment strategies—all topics that may have been introduced in earlier sessions. Said these evaluators of the tiered design:

*All professional development is about the curriculum, although project staff have made a distinction between two levels of workshops. While both focus on the curriculum, Level One workshops are more explicitly about orientation to the materials and the mathematics content. Level Two workshops are more about the pedagogy used in the curriculum. (These differences are a matter of degree, since pedagogy is a part of Level One workshops, too.) In the last year of the project, more emphasis has been placed on offering Level Two workshops.* (Evaluator, K–12 mathematics LSC)

*The program has been developmental; it has embraced the research on ways to best address teachers’ needs based on their level of use of a new educational innovation. The project has continued to deepen teachers’ knowledge of, and experience with, appropriate pedagogy to develop students’ conceptual understanding of science past the curriculum implementation stage and through its ongoing PD program.* (Evaluator, elementary science LSC)

In some LSCs, second tier offerings included study groups, as well as sessions on student notebooks, journals, and the needs of bilingual learners. Other LSCs chose depth over breadth. For example, one project focused on “one major [pedagogical] aspect each year to improve science instruction (e.g., questioning, linking science with literacy, assessment)—instead of trying to meet all needs at once.” According to the evaluator, this strategy enabled the project to involve teachers in “meaningful, substantive ways, and develop highly relevant skills.”
Meeting Needs in Pedagogy

The strength of many LSCs lies expressly in the range of formats, topics, and levels offered to teachers—an approach designed to “capture a broad stratification of teachers” over time, and meet needs in a carefully sequenced design. Said this project director: “The professional development events that take place are very consistently followed up with embedded staff development. The goal is not to have things stand alone, but to have things really be followed up, to have teachers working with each other and developing collegiality—both site-based teachers and regionally.” Evaluators also provided numerous examples of the ways in which LSCs tweaked their professional development design to better meet pedagogical needs as projects unfolded. For example, in response to teacher surveys in new LSC schools, project staff designed “extension” workshops, seminars, and school-based “Learning Forums” to address “trouble spots.” Other LSCs redesigned summer workshops to better address the needs of both beginning and experienced teachers.

In some cases, however, evaluators described programs that lacked coherence, with teachers receiving little guidance in their selection of offerings. Further, while teachers and evaluators typically described project staff as highly responsive to solicitations for help, some of the designs lacked a deliberate strategy for monitoring needs and a proactive approach for meeting these needs, relying instead on a laissez-faire approach dependent on the “interest and initiative of the individual.” Said this evaluator of the need for a more coherent and “developmental” approach, in which teachers are guided in the choices they make:

What emerged was enticing, but a smorgasbord nonetheless, a collection of events that lacked the cohesiveness of a program with logical pathways for teachers to follow. The challenge then is to readjust the overall professional development program so that it retains the richness and variety it now offers, but also provides teachers with a developmental sequence of professional experiences that build on one another.

(Evaluator, elementary science LSC)

As with content, evaluators pointed out the range in quality of professional development designed to address pedagogical knowledge and skills. There were numerous examples of high quality sessions, as described below by these evaluators:

This session demonstrated—at an exemplary level—“the whole package.” The facilitators understood extremely well the theoretical and conceptual underpinnings of the pedagogy they were trying to model and teach. They were reflective, and explicitly so, about all aspects of the pedagogical approaches they were teaching. They made connections throughout and the result was a very effective weaving together of theory and practice. (Evaluator, elementary science LSC)

Explicit attention was paid to the importance of debriefing. “Debriefing is important for problem-solving as a way of sharing divergent learning,” one facilitator commented, as she talked about debriefing in the classroom. Ways to debrief were also modeled. Many questions were asked of the teachers, such as, ‘What did you learn from this problem?’ ‘Did you learn more from doing it yourself or by watching other people solve the problem?’ (Evaluator, secondary mathematics LSC)
Even where the professional development was generally strong, however, evaluators noted the need for “more and better use” of student work to help teachers identify misconceptions. Projects that did this effectively provided opportunities for teachers to learn new teaching strategies “outside” the modules, but with clear relevance to the pedagogy needed for implementing the materials. Finally, evaluators noted the need for LSCs to give more attention to assessment, the ways in which students process information, and strategies for working with special needs students—all areas of observed weakness among classroom teachers.

**Getting the Message Across: Modeling and Discussion of Effective Teaching Strategies**

LSCs aim to instill in teachers a real sense of what it is like for students to experience the instructional materials. To achieve this goal, LSC professional development designs typically call for facilitators to model instructional strategies—to increase teachers’ awareness of what an inquiry-based lesson looks like, how to engage students in the learning process, and how to help students “make sense” of what is being taught.

Overall, evaluators noted that modeling appropriate pedagogy was a key strength of LSC professional development. In many cases, professional development providers translated the vision into practice in real and concrete ways: creating a risk-free culture in a classroom-like setting, facilitating small group work, using questioning and discussion to deepen teachers’ thinking, and engaging teachers in reflection. For example, observed these evaluators:

> [The facilitator] next discusses classroom activities to help children learn how to raise questions. Participants share how they’ve done this in their classrooms. The groups then discuss a series of prompts: “How do I use questioning in my teaching?” “What might I do differently?” “What steps can I take to change the way I use questioning?” The facilitator walks from group to group, participating in the discussion…. The session concluded with summary comments from the facilitator, noting the progression from “what is” to “what could be.” (Evaluator, elementary science LSC)

> The teacher leader effectively engaged teachers and the principal who was also participating in the session in an ongoing dialogue as they moved through the investigation. The teacher leader both modeled and explicitly addressed teachers’ use of questioning to elicit students’ thinking, ideas, and observations. She encouraged teachers to think how they would apply the processes and mathematical ideas with students, and how to use technology to engage students in mathematical thinking. (Evaluator, secondary mathematics LSC)

Although evaluators noted that appropriate modeling was a common feature of LSC professional development sessions, they also reported that the most effective professional development providers went beyond simply modeling to explicit discussions of what they were doing and why. In these cases, it was clear that the objective was to create an experience in which teachers could both learn through an inquiry approach and step outside the “learner role” to consider the pedagogical implications for their own classes. Evaluators’ observations provided these examples in which this occurred:
In the majority of instances, the nature, phase, and purpose of the inquiry is clear, and teachers proceed with a specific role toward a defined goal and set of behaviors. For example, in the Floating and Sinking [session], teachers were working to understand the materials as users of the materials. The inquiry was a scientific inquiry as learners of science directed or guided at times by the scientist or kit specialists. Upon reflection—either as an individual, with a peer, or in whole group—the teachers made scientific meaning, scientific understanding, and scientific knowledge from that experience. They then shifted their inquiry thinking to that as teachers of science and considered how to employ their internalization of scientific inquiry in the instruction and assessment of the child learner. (Evaluator, elementary science LSC)

Professional development sessions were clearly designed to “model” good teaching practices. The project directors and their mathematics educator colleague are particularly skilled at employing teaching and learning methods advocated by the Investigations materials. All three are very effective at eliciting facilitator-participant interactions as well as participant-participant interactions. Their ability to challenge participant ideas, ask probing questions, and raise content and pedagogical issues is well developed. Those elements that characterize inquiry- or investigative-oriented lessons or workshop sessions are clearly present in [LSC] training conducted by the three primary facilitators. (Evaluator, elementary mathematics LSC)

At times the participants may have gotten too far off the subject when talking about potential solutions to the problem...but they certainly experienced the learning and made the discoveries on their own....Questions such as “Is there a better way of assigning the elevators?” were built into the problem, but were [also] highlighted effectively by the facilitator. (Evaluator, secondary mathematics LSC)

Even when the emphasis is on content rather than pedagogy, the facilitators and instructors conscientiously model and point out effective teaching strategies verbally, through posters, and though handouts. For example, during the earth science institutes, instructional team members directed participating teachers’ attention to the methods they used (questioning strategies, inquiry approach, cooperative grouping, student-centered teaching, spiraling of content and revisiting of topics) at the same time as they concentrated on teachers’ understanding of earth science concepts. (Evaluator, elementary science LSC)

Evaluators also reported some “unevenness” in modeling and discussion of pedagogy, depending on the skills of the facilitator. For example, while LSC workshops were typically designed to simulate the classroom, evaluators noted that facilitators sometimes used pedagogy appropriate for students without making explicit the intent or goal of the strategy. In these cases, professional development providers sometimes “missed their chance” to clarify instructional approaches in deliberate and unambiguous ways. Described one evaluator:

[In the workshop], some of the less experienced [teachers] gave up quickly when they didn’t see the pattern or solution right away. When the facilitator asked teachers if their students would be engaged in these problems, some said no, and the opportunity to point...
out how the teachers themselves “gave up” was lost...No connection was made that this mirrored the behavior they claim their own students engage in. (Evaluator, secondary mathematics LSC)

Facilitators sometimes paid insufficient attention to how teachers could modify their own teaching based on what they had observed or experienced in the workshop. Thus, while teachers were highly engaged in the sessions, professional development providers missed the opportunity to strengthen their message by allowing teachers to reflect on how they acted as students, and how to tailor their own lessons accordingly.

While sessions typically provided teachers with a vision of appropriate pedagogy, modeling of effective pedagogical strategies was sometimes missing in sessions when providers would “slip into show and tell,” sacrificing deeper pedagogical understanding in the interest of covering additional material. For example:

Although facilitators were effective in giving their colleagues practical tips for teaching new lessons, they did not model the exemplary practices that were to be employed in implementing the lessons. Most of the teacher leaders depended too much on teacher-directed presentations, too often telling participants how to teach the lessons and what strategies to use in their classrooms, rather than demonstrating effective questioning techniques to elicit student understanding. (Evaluator, K–12 mathematics LSC)

Participants came away from this session strand understanding the importance of standards and benchmarks. Most were not moved forward in being able to apply this knowledge to their own instruction. Because of the facilitator’s emphasis on coverage of material, little room was available for participant involvement. The sessions clearly covered the facilitator’s agenda—not necessarily that of the participants. (Evaluator, elementary science LSC)

In short, while modeling effective practice was generally a strength of LSC professional development, fewer providers were adept at making these strategies explicit and classroom-relevant. Recognizing these weaknesses, some projects developed training manuals, scripts, guidebooks, and other tools for both providers (and teachers) to further reinforce the message, with examples and clear-cut pedagogical instructions.

**Support for Teachers During Implementation**

- Providing High Quality Materials
- Opportunities for Ongoing Discussion and Reflection
- Opportunities for Individualized Teacher Support
- The Strengths and Limits of Teacher Leaders in Providing Support

LSCs differ from traditional professional programs in their attention to creating a year-round support structure for teachers. While summer sessions provide intensive opportunities for participants to explore new materials and practices over a period of one or more weeks, academic year follow-up sessions offer teachers the chance to examine relevant topics in depth, as they are
engaged in implementation. LSCs used small group activities to promote ongoing discussion and reflection, and individualized support through coaching and mentoring to address specific needs. Both project-level and school-based teacher leaders played key roles in these efforts. Other areas of support provided by LSCs included materials management/refurbishment in science projects; cross-district and/or cross-school workshops; and the development of teacher-requested, topic-specific sessions.

**Providing High Quality Materials**

Hands-on instruction requires considerably more attention to consumable materials than does a textbook-oriented approach. In interviews and on questionnaires, teachers consistently spoke of the availability of materials and supplies as one of the most helpful aspects of the LSC. When the system was timely and efficient, teachers were delighted and “pleasantly surprised.” According to evaluator reports, LSCs were highly responsive to teachers’ needs in this area, “making it easy” for teachers by maintaining, restocking, and delivering materials, and keeping accurate records on dispersal and usage. In the case of some elementary science LSCs, evaluators attributed teachers’ high level of commitment and the likelihood of sustainability to an efficient and well-financed materials management system. Said these evaluators:

*The staff and executive council see the Science Materials Support Center as the one component that should determine the continued existence of the science program beyond the grant. The center’s efficiency has helped to convince teachers that the [program] is here to stay…and serves as a strong piece of evidence to the teachers that the school district is committed to the program.*  

(Evaluator, elementary science LSC)

*One of the greatest strengths of the LSC is the ready and easy availability of all the materials and supplies teachers need to implement kit-based science teaching. Teachers receive the kits on which they have been trained every quarter. In addition, aiming to foster grade level collegial interactions, the LSC ensures that teachers at the same grade level in a participating school receive the kit at the same time.*  

(Evaluator, elementary science LSC)

*The kits typically are being returned in need of refurbishment, a clear indication that they are being used. Participant comments indicate that they are teaching more science because of having the kit and the distribution systems; it is a reasonable inference that without this system, many teachers would be reluctant to continue emphasizing an activity-based approach…The combination of getting the kit when you want it and knowing that everything will be there has won over numerous teachers to the project. It appears to be a major factor in the enthusiasm seen in the third cohort, which contains a higher proportion of initially “reluctant” teachers.*  

(Evaluator, elementary science LSC)

LSC staff concurred with these observations, noting that providing materials was absolutely critical for success. Said one PI: “We hear it time and again that teachers are so relieved to have everything in those boxes. We have paid a lot of attention to make sure that this system works. If we make it easy for teachers with the materials, then we have the right to their minds.” For less experienced teachers, the teacher guides that accompanied the student materials were a “life-
line,” providing guidance on questions to ask, “checkpoints” for student understanding, embedded assessment, and in some cases, a Spanish language version for bilingual classes.

Where projects were less efficient at supplying materials, implementation efforts stalled. For example, while some LSCs were attentive to including bilingual and special education faculty, others overlooked these teachers, resulting in an inequitable access to materials. Said one evaluator of a middle school mathematics LSC: “The most substantial barrier to reaching all teachers was some districts’ failure to provide the designated materials to all schools and teachers, and to provide sufficient quantities of the materials for all regular and special education teachers. Even with a phase-in model for disseminating materials, not all teachers in the schools had materials to implement the program.”

Similarly, classroom teachers indicated some flaws with LSC materials management systems. Said one teacher in an elementary science LSC: “We all feel that there needs to be more FOSS kits and a central supply of materials. A lot of our science stuff is old and not useable. There is no cataloguing or science centers. That is what is really needed.” In this and other cases, teachers were still buying supplies out-of-pocket, and lacked access to the materials they needed—a clear disincentive to implementing the LSC modules.

**Opportunities for Ongoing Discussion and Reflection**

Both PIs and evaluators noted a growing awareness of the need to create opportunities for teachers to continue on a path of professional growth. Said this PI of an ending K–8 mathematics LSC: “It’s this notion of looking at levels of implementation. It’s easy after a couple of years of professional development for teachers to think they don’t need it anymore. So [LSCs] need to think about the next level—study groups, applied use of cases, that kind of thing—levels to help teachers reflect on and change their practices, and levels to jump-start long-term users—and to jump-start deeper thinking.”

Cross-grade and grade-level seminars, study groups, kit clubs, action research teams, “Reflecting on Teaching” groups, “Local Learning Communities,” “Roundtable” discussions, and other LSC structures provided teachers with these kinds of opportunities. It was amply clear from teachers’ comments that participants crave and appreciate the chance for this kind of support:

*The strongest and most consistently effective element of the study group format was the collaborative aspect. Teachers had the opportunity to give and receive support from each other on a much more immediate and classroom-specific basis in the school-based study groups. Teachers reported, “We discovered we could... learn from each other. We had a group to bring problems to, to meet our needs, to work together on improving instructional practices and student performance.”...When teacher leaders’ efforts were successful in preventing the study group discussions from becoming “venting” and “complaining” sessions, the study groups functioned as a valuable and essential support system for teachers who were trying out new curricula materials and new teaching strategies.* (Evaluator, secondary mathematics LSC)

*One of the most meaningful experiences was the opportunity for a group of teachers to meet and reflect on our teaching. It is rare (or uncommon) that we have the time to do
As teachers we are under time constraints and don’t take time to reflect. These reflections helped me in my teaching in science and all subjects. (Teacher, elementary science LSC)

I think the most beneficial aspect has been being able to share with all of our grade level teams, whether as a coach or as a teacher, what works, what doesn’t work with the curriculum, what concepts kids are getting or aren’t getting and how we can get there. I think having been a teacher and a coach, I am realizing that in either role, I am gaining an incredible amount by having that opportunity to share with others. (Teacher, elementary science LSC)

While teacher enthusiasm for these opportunities typically ran high, evaluators reported mixed results in LSCs’ efforts to promote ongoing learning communities. In some cases, there was a lack of continuity. Different people participated each time, and/or too much time elapsed between meetings. In other cases, group facilitators lacked a clear vision of their role, limiting the quality and impact of these activities. Said one teacher: “I was a little disappointed with the [academic year program]. I was expecting it to be an extension of what we learned in the summer, directed toward the grade levels. But it’s more generalized and I don’t walk away with as much useful material and ideas as I’d like to.” In addition, sometimes events were devoted to presentations, with little time for teacher discussion. Poor attendance by teachers was a recurring problem.

Evaluators provided numerous examples in which LSCs modified their designs to overcome barriers and enhance opportunities for ongoing teacher discussion. For example, one LSC initially used after-school kit clubs for teachers to discuss materials, content, and pedagogy. But teachers had to drive to another school to attend, and then returned to their own school to work in isolation. LSC staff altered the structure so that teachers could meet and discuss issues at their own site through case study teams at each school. The change generated more participation, and resulted in more time spent teaching science, as well as higher levels of enthusiasm for teaching. Similarly, one LSC increased the number of university faculty used as mathematics “consultants” for school-based study groups to better support targeted teachers, while another LSC refocused the roles of mathematics teacher leaders to work more with groups of teachers (as opposed to individuals) around planning and implementation.

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**Barriers to Collaboration: The School Culture**

Without question, the school culture was a major barrier to LSC efforts to create opportunities for collaborative discussion; teachers were hard-pressed to participate because of scheduling conflicts, lack of substitutes, and other demands. Similarly, as individuals and as members of building level teams, teacher leaders have struggled in theirs efforts to organize and sustain a collaborative learning structure to support ongoing teacher discussions. PIs and evaluators continue to note the need for formal roles for school-based teacher leaders as professional development providers, and the creation of formal support mechanisms. Without these, school administrators were less likely to allot time and resources for study groups, and other priorities were likely to deter teacher participation.
Some LSCs actively looked for ways to strengthen site-based discussion groups in later years of the grant—working with small groups on assessing their own needs, developing action plans, designing appropriate professional development, and monitoring progress. Other LSCs shifted their design to site-based leadership development, stepping up efforts in the final years to better prepare teacher leaders for facilitating and sustaining learning communities. With this “renewed focus,” LSCs hoped to ensure that teacher leaders were “willing and able and understood the importance of ongoing professional development at the schools.” The hope was to create job-embedded, “scaffolding” structures, with “layers of peer support” to facilitate discussions on special topics after NSF funding ended. Said one PI: “The professional development plan has gotten deeper through the years…We have different levels of teacher involvement, and have developed a strong leadership group in all of the participating sites and within the districts to work with each other.”

**Opportunities for Individualized Teacher Support**

While ongoing opportunities for shared discussion were critical, PIs, teachers, and evaluators also noted that one-on-one support—through coaching and/or mentoring—was also crucial for helping teachers to make meaningful changes in their practices. For some LSCs, coaches were “at the core of what makes the project successful.” Said this evaluator: “When looking across classroom observation data, those teachers who effectively implement the curriculum are the ones who have received more one-on-one, in-depth professional development provided through the cohort school structure.”

The benefits of coaching and mentoring were far-reaching—for individual teachers and coaches alike. Said these teachers and teacher leaders:

> The coaches have helped me in clarifying where I can improve my teaching methods. They are very positive and non-threatening. (Teacher, elementary mathematics LSC)

> [The coaches] have modeled for me many areas that I need help in. Also the debrief sessions after the coaching sessions have been great. (Teacher, elementary mathematics LSC)

> [The coaches] really work with you to help develop good assessments and lessons, very hands-on and eager to help. (Teacher, elementary mathematics LSC)

> I think for me to be able to really practice the role of a coach in-depth, again to try and bring it back to my site—it has also given me a lot of practice at facilitating which is probably for me a weaker area. (Teacher Leader, elementary science LSC)

> I wanted to get really in-depth on what the program was about and I felt the peer coaching was a component that I was still lacking, even though I had gone through the training. So this year, I am being a peer coach...It has really been the missing piece...That is what I’m taking to my own site and we are planning on following peer coaching cycles within the core team. (Teacher Leader, elementary science LSC)
Teacher interviews, however, also pointed to a dilemma described earlier: the demand for logistical support that distracts from one-on-one interaction in support of better teaching practices. For example, among the teacher comments about coaches were: “Helps me with all the materials, reorders things, a good role model”; “Keeps everyone going and up to date on what is happening”; and “Helpful to have an extra set of hands.” While these kinds of support were important for helping teachers use the modules, evaluators also cited the need for moving beyond simply implementing the materials to a greater focus on teaching for understanding through coaching and mentoring opportunities. Said this evaluator:

*One of the strongest features of the project is the individualized, one-on-one support classroom teachers receive through visitations of their assigned science resource teacher...From our perspective, there are still opportunities for re-examining the role of the [teacher on special assignment] as the project matures. As in other LSCs we have observed around the country, the [teacher on special assignment] tends to provide logistical and moral support, but rarely provides real professional development support, as might occur through the process of coaching or mentoring.* (Evaluator, elementary science LSC)

Evaluators also reported coaching or mentoring sessions that were “overly mechanical” or “superficial,” resembling “sessions in the teachers’ lounge” as opposed to well-crafted professional development opportunities. Attrition and turnover sometimes resulted in younger, less experienced coaches with limited training and undeveloped leadership skills. Scheduling conflicts contributed to the underutilization of coaching and mentoring. Finally, some teachers were reluctant to take advantage of coaching opportunities, due to a sense of apprehension about having their classroom instruction critiqued.

Although some LSCs were attentive to the preparation of teacher leaders for coaching roles—for example, providing sessions on the Cognitive Coaching model, and developing “planning and reflecting maps” to help in observing and engaging teachers in dialogue—others were less deliberate in preparing these leaders for their roles. Teacher leaders cited the need for more mentor training and “more structured” mentoring, and admitted to their inability to give teachers the time and attention they needed.

**The Strengths and Limits of Teacher Leaders in Providing Support**

By all accounts, teacher leaders are a major strength of the support system provided by LSCs, typically doing whatever it takes to help teachers during implementation. Teachers on special assignment and part-time teacher leaders who assist with summer professional development activities also play significant support roles, serving as facilitators, mentors, coaches, advocates, and “cheerleaders.” These teachers’ comments praising the work of teacher leaders were typical of those widely reported by evaluators:

*The [teacher on special assignment] hasn’t lost touch with what teaching is, and for us as a team, we see her as a true resource person, because we tell her what we need, send her a list, and immediately she gets right on it and if she can’t get it she lets us know. I have a tremendous amount of respect for her, because she has maintained contact, she knows...*
what we need, she knows the developmental stages of children, and she is very, very supportive. (Teacher, elementary science LSC)

[Teacher leaders’] support took various forms—holding grade-level meetings in their schools to discuss implementation, working individually with teachers preparing lessons, trouble shooting, locating and supplying materials, and generally functioning as a liaison between the school and the district mathematics coordinator... Teachers provided many of these services with no compensation during off hours, lunchtime, before or after school, or during their own prep periods. The impact of their obvious commitment to reform was to inspire confidence in their colleagues, which helped overcome individual teachers’ reservations or resistance to reform. In performing their role, the liaison teachers raised the comfort level and confidence of their peers significantly. This was evident in the generally higher level of classroom implementation in Year Three. (Evaluator, K–12 mathematics LSC)

In many cases, the limited number of qualified teacher leaders continues to hamper LSCs’ ability to provide ongoing support. With multiple roles in LSC projects, teacher leaders’ time is severely restricted. Few are able to provide the degree of support requested, and needed, by teachers during implementation. Some of these leaders expressed the desire to be more available for supporting teachers, but simply could not spare time from their own roles in planning and executing major project events. Said these evaluators of the challenges faced by LSCs in their efforts to provide support under these circumstances:

The project design is tailored to the needs of the participants as much as possible, constrained primarily by structural factors: the lack of time for the relatively small cadre of [teachers on special assignment] to attend to all teachers, and the vast demands on classroom teachers which inhibit them from taking advantage of all PD opportunities. (Evaluator, elementary science LSC)

[The] apparent limit in support may be a function of the absence of lead teachers in the districts, along with project staff [who] have been stretched thin by the additional schools and the geographic distribution of the schools. (Evaluator, secondary mathematics LSC)

The need for more individualized, school-based support from the facilitators is crucial. This will be even more true as the project involves teachers at higher-grade levels, who will be implementing science lessons on more complex topics. Yet while the level of facilitators’ responsibility will continue to increase with every year of the project, the original program design does not provide for any expansion of the facilitators’ time. (Evaluator, elementary science LSC)

LSC teacher leaders frequently cited concerns about meeting the pressing needs of high numbers of new teachers who are “struggling” and “overwhelmed,” while leaving other teachers unassisted. In some cases, LSCs have added sessions for new teachers, but these efforts have stretched professional development providers even further and diminished their ability to provide the necessary support for other teachers during implementation.
Strategies to Ensure Participation

LSCs are to provide all teachers in targeted schools or districts with 130 hours of high quality professional development. Evaluators consistently noted that project staff have worked diligently to reach this goal—providing opportunities for accessible and classroom-relevant professional development. Said the PI of a secondary mathematics LSC: “You have to make every effort to get the teachers there and once you get them there, you have to make sure you have something of high quality that will encourage them to come back. It has to be planned, it has to be focused, and it has to be continual.”

As noted earlier, however, while teachers were “required” to participate as part of the districts’ commitment to the program, few LSCs were able to mandate participation in professional development activities. As a result, projects relied on the sanction of schools, districts, unions, and others to support teacher participation. Some districts that adopted the designated materials as the core curriculum required teachers to participate in LSC professional development in order to receive the modules. Other incentives for participation, including college credit, stipends, salary increment credit, and state/district professional development requirements, also encouraged teachers to participate. Strong administrative support, particularly at the school level, was a critical feature for ensuring participation.

Evaluators reported that LSCs frequently modified their designs to better reach targeted teachers. For example, when attendance was poor at curriculum training workshops during the school year, one project developed summer mini-courses that addressed relevant topics, including assessment, ways to extend investigations, and using student journals. In another project, the evaluator attributed high and steady rates of participation to the LSC’s extensive and sustained recruitment efforts, for example, through meetings, presentations, and outreach efforts to principals and faculty beginning early in the school year.

Still, few teachers across LSC projects report reaching over 100 hours of professional development by the end of the project, in part because of teacher turnover, but also suggesting that project strategies for attracting teachers and sustaining their involvement over time were not adequate. (See Table 2.) It should be noted that these teacher self-report data likely underestimate the amount of LSC professional development attended. Teachers may not have always known whether a professional development session was provided by the LSC. Treatment data submitted by final year projects in their sampling frames indicate about 20 percent fewer teachers in the 0–19 hours range and 20 percent more teachers in the 100 or more hours range.

Evaluators and PIs provided some clues as to the reasons for the difficulty in meeting NSF’s goals. Contextual barriers often influenced participation rates. For example, projects experienced losses in state- and/or district-supported professional days that had previously supported mathematics and science activities; in addition, the lack of substitutes plagued LSCs’ efforts to conduct professional development during the school day. Projects reacted to these challenges by modifying professional development schedules, but participation typically diminished when activities occurred on Saturdays or after school. Teacher turnover, and the influx of new teachers because of class size reductions, also had huge implications for delivering
professional development to all targeted teachers: LSCs typically had to reach many more individuals than they planned to, and had difficulty doing so.

Table 2

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<thead>
<tr>
<th>Varying Levels of Professional Development Hours†</th>
<th>Percent of Teachers</th>
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<tbody>
<tr>
<td>0 Hours</td>
<td>29</td>
</tr>
<tr>
<td>1–19 Hours</td>
<td>20</td>
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<tr>
<td>20–39 Hours</td>
<td>13</td>
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<tr>
<td>40–59 Hours</td>
<td>10</td>
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<tr>
<td>60–79 Hours</td>
<td>7</td>
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<tr>
<td>80–99 Hours</td>
<td>5</td>
</tr>
<tr>
<td>100 or more Hours</td>
<td>16</td>
</tr>
</tbody>
</table>

†These teacher self-report data likely underestimate the amount of LSC professional development attended (see text).

LSCs also encountered difficulty in sustaining teacher involvement after the initial summer activities, with teachers foregoing follow-up professional development due to lack of time, scheduling conflicts, and competing demands. As one teacher said: “[The LSC] has given us so much, but teachers are too busy to take advantage of most of what is offered.” In addition, instilling the notion of ongoing professional growth was at times difficult: once teachers believed they "got it" (e.g., inquiry), they saw little need to participate further. It should also be noted that some evaluators suspected that low levels of treatment reflected underreporting by teachers, who may not have attributed school-based professional development (e.g., coaching) to the LSC, or who may not have associated “LSC” professional development with activities offered under the project’s local name.

Learning to use new materials and practices is also just plain hard work, and that has been a deterrent to both participation and implementation. Said one PI on the need for preparing teachers for the rigors of reform:

*Be up front with teachers—that the first year of implementing these materials will be the hardest they’ve ever worked in their whole life. They have to understand that in advance to help them persist past those days where everything seems to go wrong. If they can get past those years, it will be best thing that ever happened to them. But 6–7 months into the school year, teachers are overburdened and feel they’ll never make it.* (PI, secondary mathematics LSC)

Where districts did not adopt the designated materials, or where high stakes assessments dominated the instructional landscape, teachers may also have felt little inclination to participate in LSC professional development that they perceived as an “add-on.” Finally, when changes in school, district, and state initiatives called for new professional development priorities, teachers were sometimes less inclined to participate in LSC activities.
HIGHLIGHTS: Professional Development Programs

STRENGTHS

LSCs designed professional development programs with a range of topics and formats to address teachers’ stages of readiness and diverse needs in content and pedagogy.

LSCs worked diligently to address both content and pedagogy within the context of designated instructional materials, and in providing teachers with opportunities to explore the modules.

For the most part, LSCs addressed content in ways that were accurate and accessible for teachers, and effectively modeled instructional strategies aligned with the LSC vision.

LSCs sought to monitor gaps in teachers’ content and pedagogical knowledge in an effort to better match professional development with needs.

LSCs demonstrated a capacity and willingness to modify their professional development design in response to feedback, increasing both the breadth and depth of professional development, and the availability of offerings within school and district constraints.

LSCs sought to improve the consistency and quality of professional development by developing tools to assist providers in their work with teachers.

LSCs provided support in both one-on-one and small group settings—opportunities for teachers to reflect on and deepen their grasp of LSC materials, content, and pedagogy; over time, LSCs increasingly recognized the value of site-based professional development, and worked harder to create building-level leaders and structures to support teachers.

Teacher leaders demonstrated their willingness to support teachers in whatever ways were necessary.

LSCs excelled at providing support in the area of materials management for teachers, which subsequently increased teachers’ receptivity and support for reform.

CHALLENGES

LSCs continue to struggle with meeting teachers’ content needs, and with ensuring that teachers with the greatest content needs participated in mostly “voluntary” professional development activities.

LSCs find it difficult to strike a balance in professional development activities—between theory and practice, between content and pedagogy/materials,
between depth and breadth of coverage—and moving teachers beyond module-specific discussions and logistics, to deeper conversations around conceptual understanding and student learning.

LSCs had difficulty in bringing coherence to their professional development programs, providing adequate guidance to teachers in their professional development choices, and in devising proactive plans for meeting needs and monitoring quality.

The quality of professional development activities—both central and site-based—was highly dependent on the skills of professional development providers; there was wide variability in providers’ capacity to model and discuss effective instructional practices, and address content in ways that were both rigorous and accessible.

LSCs had to contend with teachers’ entrenched attitudes about the nature of professional development—providing them with materials and experiences that were classroom-relevant, but also delving deeper, which teachers sometimes resisted.

Coaches/mentors were widely appreciated by teachers, but often lacked the skills needed to play these roles effectively.

Teacher leaders were stretched thin—“always racing to keep up;” scaling up efforts further taxed these individuals in trying to provide adequate support to classroom teachers.

With high turnover and mobility rates among teachers, limited resources and staffing hindered LSC efforts to meet the needs of new teachers, while also attending to “experienced” teachers who were implementing the materials.

LSCs encountered numerous context and policy barriers that deterred teacher participation, and experienced limited success in meeting NSF goals for reaching all targeted teachers with the required number of professional development hours.
Impact on Teachers and Teaching

- Teachers’ Beliefs about Teaching and Learning
- Impact on Teacher Content Knowledge
- Use of Exemplary Materials
- Impact on Instructional Practices

By providing exemplary materials, high quality professional development, and ongoing support for teachers during implementation, LSCs hope to improve classroom instruction and, ultimately, student achievement in science and mathematics. The previous sections have described the nature and quality of LSC professional development, based on evaluators’ assessments and data provided by participants. This section looks at the impact of LSC projects on classroom teaching, and on teachers’ preparedness to use the designated instructional materials, and teach mathematics and science in ways guided by the LSC vision.

Teachers’ Beliefs about Teaching and Learning

Evaluators report that, overall, LSC professional development has had a powerful impact on teachers’ attitudes toward teaching. Workshop evaluations and participant interviews reveal that teachers leave professional development activities with a greater sense of enthusiasm for teaching, a heightened awareness of how students learn, a willingness to modify their teaching practices and collaborate with colleagues, and increased confidence in their ability to teach mathematics or science. Teachers attributed new beliefs about how students learn—through questioning, discovery, and reflection—to their exposure to inquiry-based instruction in LSC professional development. Said these LSC workshop participants:

* I had planned to teach in the way I was taught: mostly lecture and some hands-on activities. This forum has made me see that in order for children to truly understand the concepts of science, you must let them discover. (Teacher, elementary science LSC)

* The concept development workshops taught us to listen more attentively to the children and start from there. I have a plan in my head now—This is where we’re going. I need to remember to listen to what the children are saying. (Teacher, elementary science LSC)

* I’m not looking at students’ ability on the basis of their computation and right answers. I see the importance of getting kids to justify solutions, to use writing in mathematics. (Teacher, K–12 mathematics LSC)

* I look at students’ work completely differently now. It opened my eyes to how many different ways there are to come to the same answer. I always wanted to bring the creative investigative kind of mathematics into my classroom but I didn’t know how to assess it. There wasn’t a smooth flow of instruction and assessment before the LSC. (Teacher, K–12 mathematics LSC)
Teachers also noted important changes in their beliefs about who can learn science and mathematics. For example, prevailing attitudes among some teachers before LSC workshops included low expectations for some of their students. LSC professional development helped dispel these beliefs. Said these teachers:

*Before IMP, I felt that there were mathematically unreachable students. I felt that students could not go on to more challenging ideas like algebra, statistics, probability or trig without basic skills. Fortunately, with my IMP training, I have a different feeling about students. I strongly believe in access to mathematics for all.* (Teacher, secondary mathematics LSC)

*After the [LSC] summer school, I began to see myself as a teacher who cares very much about rich content matter (such as science) and about scaffolding that content in ways that LEP children can really grasp ideas and language.* (Teacher, elementary science LSC)

*I believed in leveling in classes—never mix top students with bottom students. Lower level students needed more structure than upper level, so they could never work well together. Beliefs now: put them all together. Even the math phobics. They will come out feeling a little bit better about math. They may even end up liking it.* (Teacher, secondary mathematics LSC)

These and many other testimonials suggest that the LSCs influenced teachers’ attitudes toward teaching and learning in important ways. At the same time, a “teacher attitudes toward teaching” composite created from such items as teachers’ views on the importance of providing concrete experience before abstract concepts, and developing students’ conceptual understanding of science/mathematics, showed only very small differences in attitudes between teachers with the highest levels of participation in the LSC and those who had not yet participated. (See Figure 4.) A summary of the impact of the LSC on this and other teacher questionnaire composites is shown in Appendix C.

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8 See Appendix B for description of composites.
Composite: Teacher Attitudes Toward Teaching

K–8 Science*

<table>
<thead>
<tr>
<th>Hours</th>
<th>0</th>
<th>1-19</th>
<th>20-39</th>
<th>40-79</th>
<th>80 or More</th>
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6–12 Science†

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<th>Hours</th>
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K–8 Mathematics*

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6–12 Mathematics*

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<td>Possible Points</td>
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<td>82</td>
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* Composite score for teachers with 80 or more hours of LSC professional development significantly different than the score for untreated teachers, $p < 0.05$.
† Due to the small number of secondary science projects, the number of teachers providing data on the 6–12 science questionnaire does not support disaggregation into five groups (0 hours, 1–19 hours, 20–39 hours, 40–79 hours, and 80 or more hours). Instead, the 6–12 science questionnaire data are disaggregated into three groups (0 hours, 1–39 hours, and 40 or more hours).

Figure 4

Impact on Teacher Content Knowledge

Teacher questionnaire data suggest that LSCs are making progress in the area of teacher content preparedness. For example, composites of teacher perceptions of content preparedness indicate that participation in LSC professional development has had a significant impact on K–8 teachers of both mathematics and science, with marked differences between untreated teachers and those who had participated in 80 or more hours of LSC professional development; the differences for treated and untreated grades 6–12 mathematics and science teachers were less pronounced. (See Figure 5.) Composite data also suggest that K–8 teachers responsible for teaching science continue to feel markedly less well prepared than their colleagues in mathematics or science at the secondary level.
Data from evaluators’ interviews with teachers also suggest that participation in LSC professional development has had a positive influence on teacher content preparedness. Among the teacher comments were:

*In each workshop, I felt that science content was covered in a way that helped me to tap into my own background knowledge, explore concepts, and construct new or additional meaning in each area. I gained a better understanding of each area and discovered some meaningful ways to connect classroom experiences with the real world.*  (Teacher, elementary science LSC)

*I have a better understanding of mathematics. I taught mathematics before without understanding the why; now I understand the content and concepts and why I’m doing things. For example, I understand standard deviation now finally because of the Pit and the Pendulum unit.*  (Teacher, secondary mathematics LSC)
Although teacher interviews and questionnaire data point to improvements, classroom observations provide a somewhat different view of teachers’ preparedness to teach content. For example, evaluators often pointed to “superficial” questions focused on vocabulary, “hurried summaries of what happened,” and limited teacher success in conveying conceptual knowledge. Said this evaluator:

A common difficulty was helping students derive meaning from observations and data. Among those receiving lower ratings, the most prominent weaknesses in the lessons related to conceptual clarity, including inadequately drawn connections among key concepts, and/or a lack of clear connections relating the results of the investigations to the concepts being explored. Such problems tended to arise from the teacher’s unfamiliarity with the inquiry process, lack of comfort with certain underlying concepts, or some combination of the two. (Evaluator, elementary science LSC)

In some cases, evaluators saw no evidence of “content expansion.” Other evaluators saw improvements, but still pointed to classroom discussions that lacked rigor, as teachers encountered discomfort moving into content areas that were still new for them. In short, it appears that many teachers have yet to effectively transfer new content into their instruction, and that LSCs have some distance to go in preparing teachers in the mathematics/science content they need.

Use of Exemplary Materials

LSCs aim to increase teachers’ use of exemplary instructional materials in the classroom, and data from both evaluators and teachers indicate progress toward meeting this goal. For example, as teachers accumulate hours in LSC professional development, they steadily increase their use of the designated instructional materials. Similarly, teachers with more hours of LSC professional development were more likely to use the modules at least once a week in their classes. (See Figure 6 and Appendix D.)

Evaluators, PIs, and others suggest that the widespread use of LSC materials in the classroom is indicative of teachers’ increased capacity and willingness to use the modules. Said one principal in an elementary school: “I have seen a lot of growth in my teachers in steering away from traditional methods where the teacher is in charge. We still have a way to go, [but] our teachers get kids excited about science. They feel more comfortable with the hands-on and are more confident using the modules.” Said these teachers about their level of comfort in using the designated materials:

I’ve been teaching for 26 years and have always been afraid of science, especially FOSS kits. I used to get them and simply open the box and shuffle stuff around so no one would know that I wasn’t teaching the kit. I NEVER used them. But then I went to the leadership institute and attended two FOSS workshops, and my life has changed. It is because of the LSC that I teach science and use the kits. (Teacher, elementary science LSC)
What has changed is my level of experience in working with this kind of curriculum, with cooperative groups, with heterogeneous classes. I am much more comfortable and probably more capable. I think I have a more realistic picture of the advantages and disadvantages of this approach and I guess I am more of a believer now in the power of this approach. I thought it should work—now I do really like it and feel more confident in its benefits...I always wanted something like this to come along. I was never happy with the one-person show. But it was hard to think things up yourself. IMP was what I was waiting for. (Teacher, secondary mathematics LSC)

![Teachers Using LSC-Designated Materials as a Basis of Lessons at Least Once a Week](chart)

Figure 6

While teachers were using LSC modules more extensively in their classes, not surprisingly, there was wide variation in how well they were implementing these materials. Classroom observations often revealed teachers who were in the early stages of implementation. For example, in trying to “speed up the process and get through it all,” some teachers paid little attention to students’ interaction with the materials. Other teachers sometimes “jumped the gun,” skipping to higher level concepts without an adequate foundation for students, or left no time for “sense-making” at the end of class to make an activity conceptually meaningful for students. Still others omitted “rich” activities, revised lessons, or added supplementary materials that “short-cut the development of conceptual understanding.” Said one evaluator: “[Teachers] had difficulty making meaningful connections between activities, or deliberately orchestrating strong closures intended to help students make meaning of the day’s activity.”
“Using the Materials” vs. “Implementing as Intended”

“Over the last two years, as project staff have monitored the level of curriculum implementation in elementary and middle schools, they have increasingly focused on the distinction between ‘using the materials’ and ‘implementing as intended.’ While large numbers of teachers are implementing the materials…this use was too often sporadic or selective…not teaching the materials as they were intended by the designers…More often than not, staff diagnosed the difficulty as unfamiliarity or discomfort with the instructional model implicit in the curriculum.” (Evaluator, K–12 mathematics LSC)

Impact on Instructional Practices

LSC evaluator reports provide much evidence to suggest that LSCs are having an impact on teachers’ instructional practices. For example, classroom observations yielded examples in which teachers demonstrated a “dynamic use of the instructional materials”—where students worked in teams, generated hypotheses, built models, and shared results. Evaluators also described cases in which teachers acted as facilitators, guided discussions, and helped students make sense of their investigations. Even in districts that did not formally adopt LSC materials, evaluators and PIs noted that teachers nevertheless looked for ways to incorporate new instructional practices—inquiry, small group learning, writing assignments, and so on.

In interviews, teachers themselves reported substantial changes in the ways they pose questions, listen, and engage students in problem-solving activities. For example:

I’m not so quick to give [students] the answer. I’ll give them time to experiment or I’ll set up something for those children to work on so that they can come up with their own answers to the questions they come up with. (Teacher, elementary science LSC)

I’ve noticed that my teaching, when I talk to the kids, I talk mostly in questions now. I don’t tell them, “Ok, this is it.” I try to lead them to understand it. (Teacher, secondary mathematics LSC)

I learned I don’t have to answer students’ questions. Let them investigate, try to come up with the answers on their own. Facilitators in the workshops would not give us the answer. I felt frustrated. They asked us to try and figure it out. I never realized that questions could make us think deeper. It changed my way of teaching. It has changed the way I ask questions and the way I don’t provide the answer. I try to teach by asking questions now. (Teacher, elementary science LSC)

My teaching is more child-centered. Wrong answers are less important. I use questioning strategies to ask, “What’s your thinking? How did you get that?” (Teacher, K–12 mathematics LSC)

It is hard to think back to pre-IMP. I was much more inclined to show students how to do a problem and then have them do similar problems—repeating the pattern. Now I am
more inclined to let students develop their own process and examine the methods of their classmates. The class time is spent in looking at the approaches people took to solve a problem. There is more emphasis on looking at a variety of ways to solve a problem. (Teacher, secondary mathematics LSC)

Teacher questionnaire data provide further evidence that LSCs have helped teachers create an “investigative culture” in the classroom (e.g., use open-ended questions, require students to explain their reasoning when giving an answer, encourage students to explain concepts to one another), and that teachers’ capacity for doing so increases with hours spent in LSC professional development. While the differences between untreated and the most highly treated teachers were significant for each group, the effects were strongest for teachers in grades K–8. (See Figure 7.)

<table>
<thead>
<tr>
<th>Composite: Investigative Culture in Science/Mathematics Classes, by Extent of Participation in LSC Professional Development</th>
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<tbody>
<tr>
<td><strong>K–8 Science</strong>*</td>
</tr>
<tr>
<td>Hours</td>
</tr>
<tr>
<td>Percent of Total Possible Points</td>
</tr>
<tr>
<td>70</td>
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</table>

| **6–12 Science***†                                         |
| Hours          | 0   | 1-39 | 40 or More |
| Percent of Total Possible Points                             |
| 70              | 75  | 78   | 77       |

| **K–8 Mathematics***                                        |
| Hours          | 0   | 1-19 | 20-39 | 40-79 | 80 or More |
| Percent of Total Possible Points                             |
| 70              | 76  | 82   | 84    | 84    | 87          |

| **6–12 Mathematics***                                       |
| Hours          | 0   | 1-19 | 20-39 | 40-79 | 80 or More |
| Percent of Total Possible Points                             |
| 70              | 79  | 78   | 81    | 84    | 85          |

* Composite score for teachers with 80 or more (40 or more for 6–12 science) hours of LSC professional development significantly different than the score for untreated teachers, p < 0.05.
† Due to the small number of secondary science projects, the number of teachers providing data on the 6–12 science questionnaire does not support disaggregation into five groups (0 hours, 1–19 hours, 20–39 hours, 40–79 hours, and 80 or more hours). Instead, the 6–12 science questionnaire data are disaggregated into three groups (0 hours, 1–39 hours, and 40 or more hours).

Figure 7
Mathematics/science lessons singled out by evaluators as particularly effective were ones in which teachers demonstrated the ability “to modify the lesson as it unfolded in response to students’ understanding.” Said this evaluator of an observation in which this type of modification occurred: “In a fourth grade geometry lesson, the teacher followed the students’ lead. The lesson on protractors took a different direction from what the teacher had planned when students’ questions revealed that they were uncertain about the concepts and wanted to clarify their understanding of angles.” Typically, these teachers also structured time into the lesson for drawing out students’ previous knowledge, and using this information to plan or modify the lessons accordingly.

Overall, evaluators noted improvement in teachers’ ability to have students actively participate in the learning process. Some teachers were particularly skilled at engaging students in discussions during investigations. In examples of high quality instruction, teachers posed ideas and approaches, engaged students through questioning, and facilitated the process of investigation. In one observed lesson, for example:

*The teacher asked questions to spur students on during their group investigations. Students were regularly asked to explain their answers to students in other groups. Conversations took place not only between teacher and student, but also between student and students. Students that responded, “I did it differently” were given time to explain their reasoning and seemed comfortable questioning each other and their teacher.*

(Evaluator, elementary mathematics LSC)

Not surprisingly, however, evaluators reported that their observations reflected the “whole spectrum of practice”—from the “rudimentary stages” of formulating open-ended questions to “accomplished discourse” in mathematics and science. Some teachers equated any kind of hands-on instruction with inquiry-based learning, thereby missing key opportunities to make conceptual connections. Others were too procedure-focused, thereby reducing the investigative nature of the materials. Teachers who lacked experience or confidence often fell back on old behaviors, for example, telling students how to get the right answer. Said one evaluator: “Teachers did not demonstrate questioning techniques to help students deepen their content knowledge…The lessons did not encourage students to think beyond where they already were in their understanding of mathematics.” Interestingly, some evaluators reported that the very flaws they had observed in LSC professional development activities—insufficient use of and discussion of questioning strategies—had subsequently manifested themselves in teachers’ classroom practices.

Data from teacher questionnaires suggest that LSCs have played a role in developing teachers’ capacity to use investigative practices in the classroom. The most highly treated teachers in each group except 6–12 science scored significantly higher than untreated teachers on an investigative practices composite that included such items as how often students engage in hands-on science/mathematics activities, and design or implement their own investigation. (See Figure 8.)
At the same time, evaluators noted some glaring differences between teacher self-reports—their ability to “talk the talk”—and their actual capacity to “walk the walk.” Many of the changes in instruction that teachers spoke about in interviews were, in the words of one evaluator, “surface changes only.” While many teachers demonstrated the ability to implement “pieces of reform,” few had yet to deliver the “whole package” to their students. Said one evaluator:

*The structure of this lesson incorporated cooperative learning and decision making, journal writing, and presenting results—all elements of a good activity. But it lacked context and purpose. Students seemed a little confused about what they were doing and eventually drifted off task. There was no closure to the lesson.* (Evaluator, elementary science LSC)

Questionnaire data indicate that teachers’ perceptions of their pedagogical preparedness increase as they participate in LSC professional development, with the most highly treated teachers scoring higher than untreated teachers, again especially at the K–8 level. (See Figure 9).
However, classroom observations contrasted mightily with teachers’ perceptions of their pedagogical preparedness, and it was clear to many evaluators that teachers were not “implementing the professional development to the degree reported on surveys.”

Given the changes LSCs ask of teachers, these stumbling blocks hardly seem surprising. Still, teachers’ perceptions of their preparedness to use new practices remains puzzling, given the challenges of using an inquiry-based approach. In part, the inconsistencies seem to stem from teachers’ limited understanding of the depth of change that LSCs seek, and the “false” sense of preparedness teachers feel about applying new practices. One evaluator explained the phenomenon this way:

This sense of preparedness that teachers have may reflect the success of their professional development experiences. We want to suggest, however, that the relatively constant and high proportion of teachers reporting this sense of preparedness may
indicate that it is a false sense of preparedness on the part of teachers. That is, we suspect that teachers do not fully understand the difficulty of appropriately implementing the designated instructional materials, let alone the difficulty of teaching for understanding. Therefore, they are reporting preparedness for something other than what they are being asked in reality to do. That the classrooms we observed did not generally reflect high levels of appropriate pedagogy and that teachers did not reflect an awareness of this in pre- and post-observation interviews suggests to us that many teachers do not have a good understanding of what effective pedagogy entails. (Evaluator, secondary mathematics LSC)

Evaluators consistently noted the extent of time, practice, and reflection required by teachers to use inquiry-based practices effectively. PIs tended to agree. Said this one:

There’s such an entrenched view that teaching is telling. That’s our big challenge—getting people to go beyond superficial use to use-as-intended. In middle schools, all teachers think they’re doing it, but it’s not launch-explore-summarize. A lot of professional development needs to be done and we have a long way to go to institutionalize ongoing professional development that is site-based and has teachers reflecting on practice. But we’re off on a good start. (PI, K–12 mathematics LSC)

In the end, some PIs and evaluators believed that the LSCs had had a limited impact, due to a design that emphasizes reaching large numbers of teachers, as opposed to effecting deep change in a smaller core of teachers. Said this evaluator of an elementary mathematics/science LSC: “[The project] provided a low level of intervention—professional development across the board to all teachers in the district. I don’t think the intensity of the professional development was enough to produce the kind of change district-wide that we wanted. It’s kind of like we changed the temperature of the ocean a couple of degrees.” In short, LSCs have laid a foundation for change, but there remains much work to be done to ensure that teachers are fully accomplished in creating a classroom that supports meaningful inquiry and investigation.
HIGHLIGHTS: Impact on Teachers and Teaching

STRENGTHS

LSCs appear to have had a positive impact on teachers’ attitudes toward teaching mathematics and science, and their beliefs about who can learn.

Increased teacher participation in LSC professional development appears to have resulted in improved classroom instruction and more frequent use of the designated instructional materials.

LSCs appear to have increased teachers’ capacity to use investigative practices and create an investigative culture in the classroom, particularly at the K–8 level.

LSCs appear to have had a positive impact on teachers’ perceptions of their preparedness to teach mathematics/science content, and to use appropriate pedagogical strategies in the classroom.

CHALLENGES

Regardless of teachers’ perceptions of their preparedness in content and pedagogy, classroom observations suggest that many teachers have persistent needs in these areas.

Although teachers are using the designated instructional materials in their classes, there remains wide variability in the extent to which they are using them as intended.

LSCs have had difficulty in moving teachers beyond “surface changes”—simply implementing new materials—to the larger task of teaching for understanding.

Although LSCs appear to have had a positive impact on teachers at all grade levels, changing attitudes and behaviors among grades 6–12 educators remains a significant challenge.
Stakeholder Support for LSC Reforms

- Gaining a Foothold with Teachers
- Principals: “A Key Cog in the Wheel”
- District Administrators: “The One Above”
- Engaging the Broader Community
- Institutionalizing Stakeholder Support

Improving classroom instruction through teacher enhancement is the major goal of LSC initiatives. However, reform leaders also have a broader mission: building support for mathematics and science education reform among district, school, and community stakeholders. PIs and evaluators alike speak of the significance of engaging those both inside and outside the school community in support of reform. Without this support, LSC reform efforts have little chance of being sustained over time.

LSCs with a history of reform have clear advantages in these efforts. With a foundation of support already established, project leaders can concentrate on designing effective professional development programs. As PIs note, however, the work of building stakeholder support for reform is “never done.” Despite an array of barriers—teacher turnover, new initiatives, conflicting policies—LSCs appear to have made progress in this area, with projects in their Final Year reporting greater stakeholder support than projects in their Baseline Year. (See Figure 10.) Further, there is some evidence that the LSCs are building structures to maintain stakeholder support after the LSC grant ends. This section looks at the ways in which LSCs have tried to build support for reform among teachers, school and district administrators, and the broader community, and the challenges they have faced in doing so.

![Composite: Stakeholder Support for Mathematics/Science Reforms during LSC Funding, by Project Year*](image)

* Composite score for Final Year projects significantly different than the score for Baseline Year projects, p < 0.05.

*Figure 10*
Gaining a Foothold with Teachers

Although a variety of stakeholders play key roles in sustaining LSC reforms, PIs and evaluators anticipate that the fate of these efforts rests primarily with the commitment of classroom teachers. Citing the widespread use of new materials and instructional strategies as evidence of extensive teacher support for reform, PIs and evaluators predict that, by and large, teachers will retain these new practices beyond the grant. Said these evaluators about the extent of teacher support:

There is plenty of “grass roots” support among teachers for [the LSC]. The great majority rate the [LSC] professional development highly, and have learned that they enjoy teaching science. Their initial forays into kit-based teaching are highly reinforced when their students typically respond with enthusiasm for science and motivation to learn more. As a result the teachers are inclined to teach more, and thus a positive feedback cycle has developed around the [LSC] reform effort. (Evaluator, elementary science LSC)

Consultants and curriculum directors may bring the vision, but it is the implementation of reforms in classrooms and the sharing of this vision by classroom teachers that institutionalize reforms. [The LSC] has built a strong cadre of teachers who believe in teaching meaning-centered mathematics...It is these teachers who will ultimately decide if the goals of the [the LSC] are sustained. (Evaluator, elementary mathematics LSC)

Your real power comes from working groups of teachers committed to the vision. We have that. Teachers remain deeply committed to keeping it going. That will not be dismantled. That’s why they’re influencing reform in other subject areas. (PI, elementary science LSC)

LSCs built the strongest base of support among teacher leaders, who in turn played critical roles in building support among the broader teaching population. Said one PI: “It’s teacher leaders working with administrators, and listening to what teachers need—actually having teachers involved in that process and in every process is absolutely critical.” Typically, LSCs used a planning and implementation process that was participatory and highly inclusive, helping to ensure support among both teacher leaders and regular classroom teachers. According to one PI, “That was the crux of the program. We took great pains to bring teachers into the program at an early stage to give them emotional and intellectual ownership.”

Still, LSCs struggled with developing “across-the-board” teacher support, and cited as many barriers to gaining widespread support as they did successes. Some PIs advocated a whole school-based or grade-level approach to professional development to ensure solid teacher support. In the absence of “critical mass” at these levels, implementation efforts encountered setbacks. In one LSC, for example, the project phased in teachers on a voluntary basis over four years, with teachers in the same grade level enrolling in different years. Said the PI: “It left teachers isolated in their implementation efforts. Without the support of their colleagues, teachers reverted and the program didn’t continue for the kids.”
Resistance at the middle and high school levels, as described earlier in this report, also prevented LSCs from getting an initial foothold of support. Teachers who felt satisfied with their current teaching, and with students’ test scores, saw no need to support reform. Others, particularly at the high school level, believed that LSC materials did not adequately prepare students for college courses. Said these individuals of the challenges in building teacher support among those who were resistant to both the vision and the professional development:

*Project staff reported that teachers themselves were the biggest barriers in their attempts to influence policies and practices related to mathematics reform in the districts in which they are working. This included both “recalcitrant” teachers, those towards the end of their careers looking to coast to retirement, and teacher turnover as teachers “escape” poor performing schools.*  

(Evaluator, secondary mathematics LSC)

*It was too much change and it happened too fast for the high school teachers. We needed to bring them along slowly, take more time to get them on board and comfortable with the idea of student-centered instruction. The window of time was too short for them to make such a major, fundamental change in their perception of mathematics. We scared them off. They perceived the change as a top-down decision imposed on them by the district and they balked.*  

(PI, K–12 mathematics LSC)

State, district, and school barriers also posed huge challenges in LSCs’ efforts to garner teacher support. For example, testing mandates left teachers frustrated and confused about how to use LSC materials and practices that, in their eyes, conflicted with traditional assessments used by states and districts. Noted one evaluator, after observing an LSC classroom: “In some ways this lesson was an excellent illustration of what can happen when teachers are very concerned with impending high-stakes testing. There is a lot of review, focus on direct instruction, attention to skills over investigation, etc. The lesson involved some tasks that could have generated some useful discussion concerning how to select a strategy for solving them. However, in an effort to do many of the tasks, that was not done.” As these excerpts from other evaluation reports illustrate, teachers frequently expressed anxiety about the incompatibility of LSC reforms and state testing programs:

*It’s hard to get it all in. By the end of the kit, I’m cramming to be finished. It worries me because in the workshops we talked about how important it was to go through the processes, to not leave anything out. But it’s impossible to get everything in, in the length of time we have. In the superintendent’s office, they are looking at the tests. That’s where it all comes from—the stress. Everyone is so unhappy. They don’t want to do it. They’re tired of all the kits. They want to get back to book work.*  

(Teacher, elementary science LSC)

*It seems like [the LSC] really wants us to get our kids to think more about the mathematical process… but the state is still testing right or wrong—that’s it—and that’s really frustrating.*  

(Teacher, elementary mathematics LSC)

*The sense in this school about tests is we are driven by them. We are measured by these standards. I hate it. But we’ve got a lot of people who won’t take the time to do inquiry*
science because of the test. Some of the units are long. It takes time to get the kids to that level. At times, it is next to impossible to get everything in. (Teacher, elementary science LSC)

If the Core Plus students don’t do at least better than a comparable group of Algebra I students, then it will be in trouble at the high school level. They aren’t going to give us another year. I think that is unfair, but it is just my reality. (Teacher, K–12 mathematics LSC)

In short, where the adoption of unaligned assessments coincided with, or followed close on the heels of, the implementation of the LSC, teachers were on a “roller coaster ride” trying to balance conflicting demands, and PIs noted little time for “getting a stronghold” of teacher support. Said one PI of an elementary mathematics LSC: “If you have a principal who says, ‘Show growth or else’, why would you take a chance? There’s a level of teacher motivation [for change] that’s not being supported [by assessment].” The adoption of textbooks that were not well aligned with the LSC vision also influenced teachers’ willingness to support reform. In some cases, teachers were instructed by administrators to use a newly adopted textbook instead of the LSC modules. In other LSCs, changes in administration translated into diminished support for the use of LSC materials, and teachers responded to these pressures by reverting to traditional methods of instruction.

LSC Strategies for Promoting Teacher Support

One evaluator described a strong base of support among teachers in the participating LSC districts. The challenge for core staff in garnering this support was to find ways to “hook teachers’ interest” and “make it easy” for them to buy in. The following strategies were particularly effective in these efforts:

- Mapping the selected instructional materials to state instructional goals and objectives, and emphasizing how the units help address these goals.
- Providing well-stocked kits and making them accessible in an organized manner to relieve teachers of the burden of seeking out and paying for items.
- Providing linkages between investigative science and other subject areas. For example, the LSC conducted workshops on integrating science with reading and mathematics; in addition, groups of teachers generated lists of appropriate trade books and stories to use with the science lessons.

As always, the lack of time—for teaching the materials, for preparation and clean-up, for professional growth activities, for collaboration with their colleagues—was also a major influence on teachers’ level of support for reform activities. Finally, teacher turnover, mobility, and the influx of new teachers continue to pose huge challenges for LSCs as they try to build widespread teacher support for reform. In the words of one evaluator about the impact of these barriers: “The efforts of those who seek to reform schooling, develop teachers to their fullest, introduce new and innovative curricula, mandate high standards, and otherwise improve the learning conditions for children in public schools are severely bounded by the constant movement of personnel within the school district.”
Principals: “A Key Cog in the Wheel”

- Strategies to Gain Support
- Some Progress
- Dropping the Ball and Other Setbacks

LSC PIs typically cited principal support as the most important factor in determining teacher participation in professional development, and in building a supportive context for reform at the building level. Not surprisingly, PIs and evaluators also noted that initial levels of principal support varied widely school-by-school, “depending on style and leadership.” Some LSCs required a high level of principal commitment prior to working with the schools to ensure a supportive environment for reform. In these cases, the LSC projects did not necessarily change principals’ vision, but merely “confirmed it.”

Strategies to Gain Support
For principals, LSCs translated into instructional resources, and these “hooks and incentives” were powerful for gaining support, particularly in low wealth districts. Other principals “looked at [the LSC] as a way to align with the standards and get good test results.” But even where principals extended their hand to the LSC, there was often a lack of understanding of the full meaning of reform—both the vision for classroom instruction and the level of commitment required to support teachers. Said this PI:

[Principals] welcomed the idea that teachers would be provided with materials and professional development and that there would be a system in place to do that. What they weren’t sure of is [the notion] of inquiry—how is the classroom going to look different? What am I going to expect when I go in? How am I going to evaluate teachers? They didn’t resist those things. They were just ambivalent because they didn’t know about it.

(PI, elementary science LSC)

Clearly the first step was educating principals about the LSC vision for improving mathematics and science instruction. But projects sometimes faced formidable barriers in their early attempts to garner principals’ support, particularly in distressed districts where principals could be highly resistant and hostile toward those bearing the reform message. Policies sometimes presented a hefty challenge in gaining “entrée” into the principal community; in other LSCs, it was just plain “bad timing.” In one case, for example, the LSC coincided with schools being put on “reconstitution watch” where principals’ jobs were at stake. Under these circumstances, principals could be tentative, at best, in their support for a new vision for mathematics and science programs. Said these PIs, when asked about the LSC’s early interactions with principals:

We got skinned alive in the first meetings. Principals did a lot of venting. They have a load, they’re overburdened. Anything they wanted we gave them the first year. We didn’t start with our issues, like here are some good science/math/technology programs and you guys get with it. We started with their issues. What do they need to be successful? What kinds of resources do you need? What strategies do we need to give them a hand? (PI, elementary mathematics/science LSC)
They were a pack of wild dogs. They were angry. They were angry and almost abusive...They were willing to sign on, but not for the right reasons. A handful really wanted to do it, but for the most part, principals committed because the LSC was the lesser of two evils. We were their saviors and they didn’t know if they wanted to be saved. (PI, elementary mathematics LSC)

Gaining the support of principals required LSCs to work within both school and district constraints, communicating the value of reform. Some LSCs deliberately sought to convey to principals that standards-based practices in mathematics or science could benefit students across the curriculum. Others looked for ways to align the LSC vision with principal “routines,” for example, teacher evaluation. Projects that targeted this issue helped principals use the LSC Classroom Observation Protocol, and developed new instruments as well. Said one PI: “We got rid of the twenty-year-old tools. Here were teachers proudly displaying new teaching strategies when the principal was in the room and the principals didn’t have anything like that on his or her observation sheet.”

LSCs typically provided annual workshops for principals—ranging from several hours to several days—to brief school administrators on goals, vision, and activities. Some LSCs also created formal structures to involve principals on a more frequent basis. For example, in one LSC, an administrative council provided the vehicle for principals to interact monthly with teacher leaders and project staff; according to the evaluator, this “open channel of communication” was invaluable for garnering the “necessary advocacy and understanding to support what the [teacher leaders] do.”

Other projects deliberately hooked into existing structures for providing professional development for principals. For example, to engage principals, one LSC tapped into the California Science Implementation Network (CSIN), where principals and assistant principals participated on school leadership teams and in training along with their teachers; through these efforts, principals “were moving in the direction of active support for reform.” Still other LSCs worked intensively with a small group of principals to cultivate their support and skills for working with their colleagues; several LSCs added Principals-in-Residence for this same purpose—released full time from their school responsibilities to work with other administrators.

Where it was difficult to convene principals, LSC staff worked one-on-one with school administrators. Some LSCs counted on teacher leaders to engage principals—through school teams, principal meetings, or individual interaction. LSCs also invited principals to participate in professional development activities for teachers to enable them to learn about new instructional materials and pedagogy.

**Some Progress**

Interviews with PIs suggest that LSC efforts to engender support among principals resulted in increased understanding of reform and diminished resistance. For example, one PI noted that the LSC turned around “skeptical administrators who weren’t convinced that anything needed to be done,” causing a “significant mindset change among principals.” Another PI commented on similar successes: “We had not targeted them as a particular audience. They tolerated it, and we
met with them. But they kept it at arms length because they thought it was a classroom thing. That’s what’s changing….It’s a learning curve for them.” In fact, in HRI interviews with 35 PIs of ending LSCs, 28 cited active support among principals—a marked improvement from when projects first embarked on their reform efforts. While a few PIs expected some backsliding, the majority predicted sustained principal support after the LSC ended; almost half of the PIs reported that districts either had plans in place to continue professional development for principals or were already implementing these types of activities.

Where principals were supportive, they were active participants in professional development, in finding ways to support teacher leaders, in budgeting new resources, in creating ways for teachers to collaborate, and in educating parents about new mathematics and science programs. Even in those districts with a long history of supporting mathematics or science prior to the LSC, PIs noted a deeper commitment among principals as a result of LSC efforts. Said one PI: “There’s always been support for mathematics and science among principals because it was the thing to do. Now they understand it. They get it. And they’re very strong advocates.” Evaluator reports also provided evidence of growing principal support:

Reports from teachers during Year Two indicate that some principals at least are becoming more proactive in their support—visiting classrooms for science activities, being more pointed in encouraging teachers to attend the summer institutes, working with project staff to schedule sessions for remaining teachers and releasing them to attend. (Evaluator, elementary science LSC)

Most principals have attended the administrator academy meetings regularly over the four years and have worked closely with their teacher leaders and parent leaders to develop plans for reform, and professional development for teachers and parents that fits the needs of the schools. (Evaluator, elementary mathematics LSC)

The principal makes it clear in many ways that he expects teachers to teach the Trailblazers curriculum. He gives teachers a clear message about it; he asks them “How’s it going?” He meets regularly with grade level teachers and that’s where the message gets communicated. (Teacher, K–12 mathematics LSC)

When LSCs occurred in tandem with state and/or district policies pushing improvements in mathematics and science, principal support was usually forthcoming, “whether they like it or not.” In these cases, PIs noted that the LSC’s role in supporting relevant policies was absolutely critical to gaining principal buy-in. Said this PI:

The state’s graduation requirement was probably the single most important thing that steered the principals our way to cooperate in this project, because we could show them that, using these curricula, students could satisfy all state requirements in three years. [The traditional curriculum took four years.] So they saw the LSC materials as a way their own students could satisfy graduation requirements much more efficiently. That was a big reason, if not the biggest, that they were willing to buy into the LSC. (PI, secondary mathematics LSC)
Demonstrated improvement in student performance was key to gaining principal support. Said one PI: “That was the stamp of approval. So even those who didn’t understand it said it must work, and I’m not going to get in your way.” Said another PI of a K–12 mathematics LSC: “One reason [for diminished resistance] has been the data showing kids in schools with strong implementation have improved their test scores. That was a big plus for convincing principals.” Finally, word-of-mouth praise for LSCs among their teaching staff was critical. Said one PI: “Once teachers got going, resistant principals really became advocates.” Added another: “We saw this time and time again. When teachers are saying those sorts of things, principals hear that.”

Securing principal ownership of reform remains a challenge for LSCs, however. Evaluators noted that while principals often proclaimed support, there was sometimes a considerable gap between their words and actions. Said these individuals:

*The principal is an admirer of [the LSC] but he’s neutral in the school; he doesn’t get actively engaged in the mathematics reform; he doesn’t seek out information himself; he doesn’t want to know the details. He expects the lead teachers to do it all.* (Teacher, K–12 mathematics LSC)

*If you asked principals, they would say science is important, but if you look at what they’re doing in their building, it’s a different matter.* (PI, elementary science LSC)

*There wasn’t the sense of ownership or school-level commitment that [the project] would have liked. They thought it was a great idea and liked the idea of the district having professional development to move teachers in that direction, but they didn’t feel the commitment to ensure that that happened in terms of instruction in the classroom.* (Evaluator, elementary mathematics/science LSC)

In short, while school administrators were supportive, they were also preoccupied with competing agendas. Evaluators sometimes attributed teachers’ limited buy-in to the lack of active support from principals—where principals provided “lip service” to reform, but no clear expectations for teachers to use the materials or participate in professional development.

**Dropping the Ball and Other Setbacks**

In hindsight, there was a distinct recognition by PIs that, like teachers, principals needed ongoing opportunities over time to absorb the vision and changes advocated by the LSC. The message was clear: engage principals early and often. In the eyes of evaluators and PIs, LSCs that cultivated commitment from principals and created “formal and clearly articulated” leadership roles for principals within the project and in their schools stood a better chance of sustaining reforms. But initially LSCs were sometimes unclear about the roles principals needed to play, and how best to prepare them to carry out those roles.

Limited resources also significantly influenced the level of attention LSCs devoted to principals, and as a result, projects at times neglected these key stakeholders. For example, one PI described early efforts to engage principals by linking them with teacher leader teams that were working extensively with the LSC. Said the PI: “[But then] we took our eyes off the principals.
It was not a conscious decision, but the work was so overwhelming that we focused on the professional development of teachers.” In the last two years of the project, the LSC refocused their attention on principals, convening a small group, “admitting” their error of omission, and giving principals recognition as “critical players.” The group then set about developing a long-term plan for a professional development program for principals, based on their needs and priorities.

Other LSCs noted that they too had “let the ball drop.” Said one PI: “We didn’t do that very well up front. That was a flaw in our thinking. We provided some opportunities for [principals] to participate, but they didn’t work and we dragged our feet.” Looking back, other PIs concurred that “it was a mistake not to keep [principals] on board the whole time.” Said these individuals about the importance of formal, ongoing work with principals:

Over 4–5 years, the LSC averaged three half-day sessions for principals a year…We were thinking that we needed to keep bringing them along…You can tell them one or two times and they’ll remember for a little while, but they have to experience what’s going on in the school, and at the same time, you have to reinforce them about the behavior of their teachers in the classroom—that it’s different from the past and we should respect that and evaluate that based on this new model [for instruction], as opposed to [judging by] how quiet the kids are and how straight the rows are. (PI, secondary mathematics LSC)

[You have to] be strategic about inserting as much of the project into the management routine and structure. For example, look at what principals have to do. If they have to do those things anyway, why not align [LSC activities] with that. We should have done that a long time ago. So think of management routines. Don’t think of what you’re doing as an add-on. If you are adding something, you’re probably not going about it in the right way. (PI, elementary mathematics/science LSC)

In retrospect, we didn’t do enough with principals. It was a real hole in our work over the last several years. We expected that because of principals’ interest, that they would come to many of the sessions that teachers came to. That didn’t happen. Again, plant that in the statewide context. Reading was driving everything that was going on in [the state]. So principals were also being given professional development in reading, literacy, what they needed to see in the classroom. That’s where their heads were. But we needed to get to—what does professional development for principals look like beyond attending similar kinds of things as teachers. (PI, K–12 mathematics LSC)

Within districts, these and other barriers—instructional materials adoptions that countered the LSC vision, reassignment or replacement of principals, changes in district administrators, high stakes tests—shifted the emphasis away from LSC subjects, and influenced the extent to which LSCs were able to fully engage principals. Noted one PI: “Given the pressure on principals to increase [student] performance and the messages from [the central office] that [LSC materials] may not be appropriate, permanence is never a sure thing.” Other individuals also commented on the impact of the ever-evolving context for reform on principals’ level of commitment to LSC reforms.
These are small counties, with few resources, high minorities. They’ve never done well on the [state test], and funds are tied to the test. They’re under the gun by districts and school boards to show growth. Passing the tests was the priority. Some principals said, “Our first goal is to pass the test, and I don’t care how you do it.” (PI, elementary mathematics LSC)

Principals’ support remained stable for first three years and then superintendents changed. Then the ground started shaking a lot more. Their job depends on reading and mathematics scores. The degree to which they support science is less and less as the stakes in literacy and mathematics arose. (PI, elementary science LSC)

In 1998–99 [two years into the LSC], a monkey wrench [SAT 9] was thrown into the system…That unraveled very quickly a lot of the work we had done to promote investigative and hands-on mathematics and science. (Evaluator, elementary mathematics/science LSC)

In short, the support of principals remains fragile in the face of conflicting priorities, budget crises, and the limited time school administrators have to devote to any one initiative. Aware of the barriers, some LSCs remained resolute—working within constraints, pushing the message, and “waiting it out.” Said one PI about the need for patience, as well as strategies for engaging principals: “I don’t know how much you can force people. Our strategy was to wait for people to be ready, which of course means that, to a degree, we’re still waiting.”

What PIs of Ending LSCs Said About Building Principal Support

“What we found, it was really a function of the principals as to whether [the LSC] stayed as a priority for the five years.”

“The vision of the principal is a key determinant of how well standards-based science is implemented within a school.”

“We learned that IMP worked in schools where administrators knew about the program and were actively supportive. Where administrators embraced IMP, it grew year by year until it was the mathematics program.”

“Never stop working with principals. You can never do enough to get them to understand what this kind of science is all about, what it looks like in the classroom, what it means in terms how it enhances their vision of literacy acquisition. The most important cog in the wheel is the building principal.”
District Administrators: “The One Above”

- Strategies for Gaining Support
- Some Progress
- The Toll of Turnover and Other Setbacks

While principals provide crucial support at the building level, they are accountable to superintendents, other central office administrators, and school boards—local policymakers who can make or break reform efforts. Where LSCs established strong working relationships with district administrators, PIs and evaluators noted that the potential for sustained support increased significantly. Gaining this support required project staff to be vigilant in meeting with administrators “at each step of the process,” working proactively and strategically to demonstrate how LSC reforms support district priorities, and designing plans (and alternatives) tailored to district needs. Said one PI: “We felt if the central office isn’t behind it, then the principals certainly aren’t going to get behind it. You have to keep everyone informed so the one above is able to put pressure on the one below.”

Strategies for Gaining Support
As with principals, initial support for the LSC vision ranged considerably among district administrators. In some cases, there was a long history of reform—where the school board, superintendent, and other central office personnel were already promoting a vision for mathematics and science education that was highly aligned with the LSC. In contrast, other districts had no such luxury. Overall, prior to the LSC, PIs reported little awareness among district administrators on issues related to high quality mathematics/science instruction and the professional development needed to support these programs. Said one PI: “The attitude was let’s just keep the ship moving smoothly. Don’t rock the boat. Don’t do anything that provokes calls from parents.”

Project leaders focused much of their efforts on engaging superintendents—working one-on-one, attending district meetings, inviting superintendents to visit classrooms and teacher professional development, and framing reform efforts in ways that clarified student benefits across subjects. LSCs also created formal structures for convening superintendents and other administrators, particularly in projects that involved a number of districts. For example, in one elementary science project, an LSC administrative council met quarterly with superintendents and others to review progress and solicit input. During the LSC’s Final Year, the council focused on ways to sustain reform—through a materials management system, professional development, and plans for expanding the reform to the middle school level; beyond the LSC grant, the council continues as a strong forum for communication and decision-making.

Other LSCs used similar kinds of structures to garner support from district administrators, looking to engage those who were well positioned to influence superintendents on issues related to professional development, curriculum, and instruction. Said this evaluator on the importance of providing opportunities for participation, and the implications for building support across districts:

*The five districts have a history of working together. The [intermediate education agency] to which the districts belong provides a ready forum for collaboration. The five...*
superintendents (and other district representatives) meet regularly. Because of their existing buy-in to the LSC project, if one district starts to waver in its commitment, the other superintendents can exert collegial influence to maintain the momentum.

(Evaluator, elementary science LSC)

LSCs that involved a number of districts often had to walk a fine line in building district support, without appearing to “meddle” or push an outsider’s agenda. University-based PIs, for example, emphasized the need for an “indirect” approach—one that puts outreach to superintendents, school boards, and others in the hands of staff in the individual districts, thereby avoiding “the appearance of the carpetbagger coming in.” Said these PIs:

There is lots of pressure on the urban districts in [the state] in terms of testing. What we tried to do was to show people how they could make themselves look good and make the superintendent look good. We tried to generate a sense that we’re in there to help. It didn’t always work. People felt threatened by us, that we would take away from them… We never did anything without running it past them first. (PI, elementary science LSC)

We didn’t work with superintendents specifically. Some were involved in full day meetings…but there’s a pecking order and who gets to work with the superintendent is a matter of protocol. In retrospect, there were one or two districts where we should have been more involved…When you have [teachers] that don’t share the vision, you really do need strong administration. And we learned that. The administration needs to step up and help people examine their beliefs, instead of just valuing everyone’s points of view. But you have to be careful and go to people in the districts in terms of working with high-level administrators. (PI, secondary mathematics LSC)

Efforts to gain the support of district administrators also revolved around weaving the LSC vision into the “district fabric.” For example, project staff and teacher leaders participated on district committees for frameworks, curriculum, assessment, and professional development to give voice to the LSC vision among central office staff. Some LSCs planned and advertised professional development through the district offices, and coordinated with central office departments—staff development, evaluation, literacy, bilingual, and special education—to broaden the reach. In an elementary science LSC, for example, project staff held monthly meetings with elementary education directors from the four participating districts; meetings were consistently well-attended, with discussions focused on strategic planning, professional development, and district policies to support reform. In another elementary LSC, efforts to garner support from the district Professional Development and Career Ladder Departments resulted in changes in vision and policy for teacher preparation and professional growth, and the adoption of new incentives for teacher participation.

**Some Progress**

PIs and evaluators reported that district administrators have demonstrated tangible support for LSC reforms through fiscal commitments for teacher stipends and for teacher leaders; released time for coaches, mentors, and others; the adoption and purchase of exemplary materials; “spirited defenses” of curriculum decisions; and cost-sharing that exceeded what was originally proposed. One PI noted that, by the end of the project, the science budget was more than three
times higher than it was before the LSC. In another project, the participating districts adopted a common vision aligned with the LSC; pedagogy and professional development strategies advocated by the LSC have now become the model curriculum-wide, resulting in new ways of thinking about the teaching of core subjects. Other LSCs pointed to the increased willingness of district administrators to provide support for reform. From these evaluation reports:

I’m speaking from my own district now and there is no question the program will continue. We have made a commitment to continue the stipends for the lead teachers. One thing we have done is to use an increasingly larger proportion of money to support some release time for the lead teachers. That is something that is accepted and will continue because there is a great commitment to continue the program. (Evaluator, elementary science LSC, quoting a district administrator)

The district administration and Board of Education decision to stay the course with their framework and curriculum adoptions in light of recent changes in the [state] mathematics framework and recommended curriculum is evidence of their high level of commitment to quality reform mathematics curriculum. (Evaluator, elementary mathematics LSC)

The [school board members] support us in terms of improving our program, we support them by continuing to contribute to our capacity building and our knowledge base. That is something the board members understand and they want to participate in that…They are very attentive to that type of activity and we have at least 4 board members that are constantly asking the questions around the math, science, and technology areas. They are always on it. (Evaluator, elementary science LSC, quoting a district administrator)

As with principals, teacher enthusiasm sometimes played a role in convincing district administrators of the value of LSC reforms. Said one PI: “What we’re hearing from teachers is that they don’t care if the standards go away, [they’re saying], ‘I’ll never return to the kind of teaching I did before,’ because they see student success. That kind of attitude plays off to administrators and school boards rather well.” Finally, where LSCs resulted in improved student achievement, district administrators took note. Said one PI: “There’s nothing like headlines that say ‘mathematics scores soar’ to put the school board on your side.”

The Toll of Turnover and Other Setbacks
While these successes emerged from evaluation reports and PI interviews, so also did the enormous effect of turnover and the “relentless” work of cultivating support among district administrators. Administrative turnover was cited most frequently by PIs of ending LSCs as the greatest challenge in trying to implement reforms. Instability in district leadership sometimes “blurred the message” about the direction of mathematics and science education, which in turn affected implementation in the schools. LSCs met with new administrators to maintain some continuity and build awareness for the LSC vision, but PIs often failed to anticipate the extent of turnover and its implications for reform. Said these evaluators and PIs:
[The biggest challenge] was the ever-changing administration...It’s been difficult to work with someone for a year or two and have them leave and [then have to] educate the next one and the next one.  (PI, elementary science LSC)

It’s the sense that we’ve had to do constant intervention...It’s sort of like we’re on a treadmill, where we constantly think about new teachers and new principals and new superintendents. That has been a real impediment.  (PI, elementary mathematics/science LSC)

Since the project began, there has been continual turnover in superintendents and mathematics coordinators in three of the four districts in the project....It takes time with every transition to work out the kinks and get the administrators on board.  (Evaluator, secondary mathematics LSC)

With the investment in professional development and the kind of multi-level efforts necessary to create and sustain reform, this kind of turnover can be devastating. Changes in supervisory leadership, loss of experienced and well trained teachers, and turnover of principals and other key individuals have created the biggest barriers to reform.  (Evaluator, elementary science LSC)

You have to be prepared to withstand all of the administrative and political upheavals. You have to be ready at the drop of a hat to tell your story repeatedly to all different kinds of audiences. Make sure your plank is in every administrative platform...
With every change [of administration], you have to go argue your case one more time. Our co-PI says, “The storm is here. You can’t control the wind, but you can adjust your sails.” So for each new administrator, we asked, what are they interested in, how can we present it in a way that aligns with their goals and still honor ours. But what happens is that you’re never done. You can never say something’s in place. It can always be challenged. That I found to be incredibly debilitating.  (PI, elementary mathematics LSC)

Although the majority of PIs noted that superintendents were the most important district administrators to have on their side, others characterized school boards and central office staff as the “neglected people”—administrators they should have paid closer attention to. Some PIs noted the lack of a clear strategy and inadequate resources for cultivating support. Others cited a laissez-faire approach that was limited in its effectiveness. Some LSCs left the task to teacher leaders, but PIs noted the limitations of this approach and the need for “someone higher” to “keep up the momentum.” Said one PI: “The least successful [districts] were where it was left to teachers to make things happen.” Where there were few “strong voices” for reform among district administrators, PIs questioned the sustainability of reform efforts. Noted one PI: “[Success is] leadership-related. You need that voice for reform. Teachers have a sense of it, but they don’t have that level of voice or influence.”

Other LSCs encountered serious turf issues in trying to work with central office staff, characterized by one PI as “independent fiefdoms—a moving target that we never got to.” Finally, even LSCs that had created formal structures to increase awareness and ownership among district administrators found that the project carried less weight in its later years, when
only limited NSF funds remained. Said one PI: “It works for a while, especially early on, when there’s $3–4 million, but by the time the money is spent, the program had no clout with the new superintendent.”

In spite of these barriers, the majority of PIs interviewed by HRI reported that their LSCs were successful at increasing administrative support for reform at the district level, citing higher levels of commitment than when the LSC began. But clearly the longevity of this support is never fully guaranteed, requiring project staff to continually “drive home” their message in a variety of ways with superintendents, school boards, and central office staff.

**Engaging the Broader Community**

- **Parents**
- **Unions**
- **Partnerships**

Beyond teachers and administrators, PIs and evaluators noted the need for engaging the broader community—parents, universities, business leaders, unions, and others—in support of mathematics and science education reform. Parents can apply pressure by demanding LSC-prepared teachers for their children. University and business partners can provide stability, credibility, and clout. Unions can help ensure that teachers participate in LSC professional development.

**Parents**

Nearly half of the 35 PIs interviewed by HRI noted progress in gaining parent support for reform by the time the LSC ended. Typically, parent outreach efforts occurred at the school level, as opposed to project-wide, especially in LSCs targeting multiple districts spread over large geographical areas. “Awareness” workshops, leadership development seminars for parents, Family Math and Science Nights, and printed materials about the LSC vision and instructional materials were among the strategies used by LSCs to gain parent support. Some LSCs also looked for innovative ways to engage parents as partners in reform—for example, as volunteer “associates” to assist with materials management. Evaluators noted examples in which LSCs developed new roles for parents and sought to increase the status of LSC subjects in the community:

> [Parents] have participated actively in the parent leadership training activities over the past three years, have worked at the school site and in district meetings with their principal and teacher leaders to plan the mathematics education reform at their schools, and have collaborated in leading Family Math Partnership evening with teachers at their schools. (Evaluator, elementary mathematics LSC)

> Another example of how communicating to parents the district’s growing prioritization of science is the inclusion of science on an annual survey sent to all parents in the district. Although a minor adjustment in the survey, this action went a long way in sending the message that science is part of the district’s overall goals in improving the education of all students. (Evaluator, elementary science LSC)
When parents participated in LSC activities, projects reported high levels of enthusiasm. Overall, however, projects continue to struggle with garnering community support, and it remains an area in which PIs and evaluators note the need for better planning and more resources. Typically, LSCs reached only “small pockets” of parents, resulting in only low levels of awareness. Said these evaluators:

*Parent support seems to be limited. For example, this year about half of the principals reported [on the principal questionnaire] that most parents are voicing neither opposition nor support for the LSC approach in the classroom.* (Evaluator, secondary mathematics LSC)

*Parents neither express strong support or opposition for standards-based mathematics instruction.* (Evaluator, elementary mathematics LSC)

*Principals and teachers are uncertain about parental support.* (Evaluator, elementary science LSC)

Evaluators and PIs gave examples in which LSCs “started strong” in parent outreach, but over time, these efforts faltered. For example, several PIs noted that while project-wide parent outreach efforts worked well at first, during subsequent years, participation dropped off; LSC staff saw it “wasn’t going anywhere,” and left parent outreach to individual schools. Other PIs cited examples where teachers expended a high level of effort to conduct school-based parent activities, but few parents attended, and efforts “fizzled.” Finally, some PIs noted that they had initiated parent activities, or planned to, but the work of professional development soon superceded these efforts. Said this PI: “[Parent involvement]—that’s probably one of our greatest failures…. [We kept saying] we’ll get to that next semester, when things have quieted down a little bit…. We knew then it was going to take a lot more time and effort than we were able to devote to it to be successful.”

PIs of LSCs targeting mathematics were particularly aware of the challenges of engaging the community, due to the “math wars” and the prevalence of “back-to-basics” proponents. For example, in one LSC, where a well-established hands-on, inquiry-based science program was “old news,” mathematics was more problematic. Said the PI: “Parents have a lot of traditional thoughts about mathematics. We had to be careful about saying we have the answer because you set yourself up. You try to make sure that your kids have success, and that scores go up, which they did. But we didn’t say ours is right, yours is wrong.”

Other PIs of mathematics LSCs reported using a similarly “cautious” approach. For example, one project used a highly inclusive, community-oriented process for reviewing instructional materials so that the LSC wouldn’t get “ambushed.” Another worked with small groups of parents “very deliberately…mainly because of the bad press that mathematics programs had gotten. We didn’t want to be blind-sided.” This particular LSC brought in an outside consultant, organized small groups of parents at night, offered childcare to encourage attendance, and used business volunteers to help. Said these PIs of other mathematics LSCs about the importance of providing a voice for reform to counter existing and potential opposition:
Most parents [in the LSC districts] are forward looking in terms of their view of mathematics instruction. But it doesn’t take very many outspoken back-to-basics people to raise concerns and questions from other parents. When you change the game—the content and mode of instruction—kids that had difficulty before are finding mathematics more enjoyable and easier. Those who succeeded at a more algorithmic approach are now finding it harder. So [some] parents have kids who are no longer getting A’s and this is a problem—an emotional one—[and] it may not take very many of those kinds of parents to raise questions for the middle of the road kids. (PI, secondary mathematics LSC)

The LSC had a short honeymoon period where things were going well. A lot of people had the opinion that mathematics was math, nothing will change, so just do whatever you want. Then people who had benefited in the old system all of a sudden started to realize that more kids were taking mathematics and they perceived that as a negative reflection on their child. These parents raised concerns in districts and recruited mathematicians who got involved to see that their domains were protected. [It was] energy zapping and disheartening. (PI, secondary mathematics LSC)

Be very aware of what the community is thinking. There is a need to figure out how to work within the community. You need to prepare a column for principals to distribute in newsletters. Invite parents in. If you hear something negative, don’t just assume that it will go away. Don’t assume they don’t know what they’re talking about...When someone says something negative, if you don’t deal with it, that’s the message that’s left out in the community. If you don’t have a way to dispel that or communicate the good things that are coming out of the project, then that message becomes the only message that’s out there in the field. (PI, K–12 mathematics LSC)

Unions
LSCs’ experiences with building support among teacher unions reflected that of parent outreach activities—a somewhat hands-off approach that resulted in neither much support nor much opposition to reform. There were examples of solid success, in which union leaders participated in the original design of the LSC, promoted the program in union newsletters, supported the adoption of new materials, and shifted their positions to support more professional development in teachers’ contracts. Evaluators and PIs also described pockets of resistance, for example, in some cases, unions raised issues about time and compensation for teachers participating in LSC professional development outside the school day.

Efforts to secure union support occurred primarily through the work of teachers who played leadership roles in both their unions and in the LSC, and who sought buy-in and communicated vision and progress through their union involvement. It appeared from PI interviews, however, that few LSCs had a proactive strategy for garnering union support. Rather, strong word-of-mouth “advertising” by teachers, as well as shared data on improved student achievement, appeared to be the key strategies for bolstering union support. PIs of ending LSCs interviewed by HRI typically cited no change in union sentiment toward reform over the course of the project.
Partnerships
LSCs advised building on existing partnerships and creating new ones to gain broad-based support for reform. Many projects featured formal partnerships with universities, and these relationships have considerably extended reform efforts. Typically, LSCs collaborated with colleges and universities on professional development activities, but PIs advised going beyond these roles to “permeate” the education department, to alter the culture around teaching and learning, and to inspire universities to work with districts in developing appropriate courses and giving credit for professional development.

LSCs reported communicating their vision through meetings with university faculty and administrators, hiring liaisons to facilitate partnerships between the university and the district, and working with education departments to ensure that student teachers were exposed to LSC instructional materials and student teaching experiences in LSC schools. Universities have also co-sponsored Inquiry Institutes; provided in-kind support for facilities and staffing of materials management centers; and developed pre-service and in-service mathematics/science courses that hold potential for sustained professional growth experiences for teachers. Said these evaluators of cases in which LSCs successfully built district/university partnerships, and the implications for sustaining reform:

Collaborations with the university have helped seal [an LSC]-infused philosophy as well as a strong working hand into the university’s science-related offerings. Together the university and [LSC] have designed courses and programs that reflect the LSC vision, and through their work with the teachers who serve the districts have helped steadily implement that vision in the classroom. (Evaluator, elementary science LSC)

The faculty and staff at the [university] have a long-standing relationship with the district and that relationship has continued to be a productive and cooperative one throughout the four years of the [LSC]. University faculty and mathematics educators are continuing to work with the district in the fifth year extension of the project, and plans are underway for continuing collaboration in state-funded professional development in mathematics education. (Evaluator, elementary mathematics LSC)

The college is moving to link its elementary science education program to the [LSC] project, using the LSC materials as a context for exploring standards and pedagogy in the science methods course. Elementary teachers graduating from [the college] will have had experiences similar to teachers in the LSC summer institutes. Thus, as the districts encounter an expected wave of retirements in their aging teaching population, they will have access to new teachers ready to step into the program. (Evaluator, elementary science LSC)
Building Partnerships

LSCs have successfully built “diverse” partnerships and “significant collaborations” with informal science partners, research institutions, and professional development centers. Some projects actively sought business support, giving presentations to local businesses, and sponsoring school-based and project-wide activities to increase awareness and show appreciation for support. Others described successful collaborative community efforts, for example, to engage local scientists and engineers. In the face of administrative turnover, fluctuating policies, and shifting political climates, these business partners have sometimes acted “as an anchor” for reform. For example, a PI of an ending elementary mathematics/science LSC pointed out the powerful role an intermediary organization (in this case, a business corporation) can play in reform—as a source of financial support for quality mathematics and science programs, and as an entity well-positioned to influence policy.

Some LSCs successfully formalized partnerships through the creation of university-based centers, with clear functions for sustaining reform—for example, in disseminating materials and professional development to both LSC and non-LSC districts. Said one evaluator about the role the project played in establishing partnerships that remained powerful forces in supporting reform: “An important outcome of the project has been the development of the ‘partnership’ among the five districts and the university…Each partner has brought considerable local strengths to the table to share with the others; each has been willing to explore new ideas presented and to re-examine local practices that stood in the way of achieving their goals. As the grant ends, there is every indication that this partnership will endure.” Another evaluator made a similar point:

An important and far-reaching strength of the LSC professional development is the infrastructure of relationships and connections the project has deliberately established to support professional development for teachers in particular, and the science improvement effort in general. They include relationships with all 14 school districts; the strong working relationship with the local university…as well as numerous relationships with groups and professional development providers around the United States. The achievement of establishing the current network of collaborations is a special highlight of the project, given the previous history where working relationships among these groups were noticeably lacking. (Evaluator, elementary science LSC)

As with strategies to involve parents and unions, however, LSC efforts to build partnerships were limited by time, resources, and the demands of the LSCs’ primary mission—teacher enhancement. These limitations were made abundantly clear by this evaluator:

During an interview, the PI and project staff were asked what they would do differently if they had the chance to start over again. One of the areas they suggested was that they would include another staff person to act as a community contact with parents and scientists. Prior to the beginning of the project, local scientists were contacted and asked if they would be interested in participating. Initial interest on their part was high, with one hundred and eighty scientists responding positively. Once the [LSC] team became involved in the demands of the project, however, it was difficult to provide consistent
opportunities to involve all the scientists. There was not enough staff time to devote to this aspect of the project. (Evaluator, elementary science LSC)

Ownership of reform also complicates the picture when LSCs team universities or others with school districts. Clearly, “outsiders” offer strengths as partners in reform, bringing new resources and energy to entrenched school systems. For many LSCs, reform efforts would not have been initiated without the impetus from university faculty. Said this PI: “The district took ownership and bought in, but the fact is none of this would have happened without [the university] and if the university consortium hadn’t pushed and niggled and set up the advisory board and school district board. That relationship between the local university and other organizations and the school district is absolutely crucial.”

On the other hand, partners outside the district also run the risk of neglecting efforts to build local support to ensure the sustainability of reforms. In interviews, university-based PIs of completed LSCs were typically out of touch with districts, and unaware of what had transpired since NSF funding had ended. To a large degree, these PIs leave reform efforts wholly dependent on the leadership and capacity left behind in the districts and schools. In the case of high needs districts, partnerships may be particularly one-sided, leaving school systems especially vulnerable.

Institutionalizing Stakeholder Support

Garnering stakeholder support has been a key element of the LSC program, and the ability of the projects to sustain that support beyond the life of the grant may be an important predictor of the institutionalization of the entire reform effort. To gauge the likelihood of continued stakeholder support, a composite variable was created to measure the extent to which the district(s) in the LSCs have systems in place for garnering and maintaining support for mathematics/science reform from various stakeholder groups including teachers, principals, and parents. LSCs appear to be creating these systems over the life of the grant as projects in their Final Year scored higher on this composite than projects in their Baseline Year. (See Figure 11.) Further, LSCs in their Final Year indicate a fairly high likelihood that these systems will exist after LSC funding has ended. While having systems in place certainly does not guarantee support for mathematics/science reform, the existence of these systems does increase the likelihood of support.
Figure 11

Composite: Existence of Systems to Sustain Stakeholder Support for Mathematics/Science Reform, by Project Year*

* Composite score for Final Year projects significantly different than the score for Baseline Year projects, p < 0.05; composite score for Final Year, likely to exist after the LSC significantly different than the score for Final Year projects, p < 0.05.
HIGHLIGHTS: Stakeholder Support for LSC Reforms

Successes

LSC efforts to engage stakeholders appear to have resulted in increased support over time among teachers, principals, and district administrators, with predictions for sustained support after the LSC grant.

LSCs successfully created new structures for working with administrators and tapped into existing ones to build awareness and support.

Administrators demonstrated their commitment in tangible ways: attending professional development, supporting teacher leaders, adopting and purchasing LSC-designated materials, providing substitutes and stipends, and adjusting schedules to allow teachers to collaborate.

In the face of conflicting policies, LSCs sought to demonstrate how reforms fit with school/district priorities, and the ways in which the designated instructional materials supported state standards and improved student achievement.

LSCs built strong relationships with universities and other partners that allowed them to expand and, in some cases, sustain their efforts through newly created professional development and materials management structures.

Challenges

LSCs were highly preoccupied with providing professional development and support to teachers, and lacked the time and resources needed to build broad support among stakeholders.

Few LSCs articulated a strategic plan for engaging stakeholders, sometimes resulting in a *laissez-faire* approach, “neglect,” and/or “fits and starts” in working with administrators, parents, and others.

To the end, LSCs struggled with overcoming pockets of resistance among teachers and, in some cases, parents and administrators.

Administrator support was often characterized as “lip service,” without the commitment to reform that LSCs would have liked.

Turnover among administrators resulted in detours and discouragement, requiring constant efforts on the part of LSCs to convey their reform message again and again.
Institutionalization of the LSC Vision and Reforms: Legacies and Predictions

- Capacity and Infrastructure to Sustain LSC Professional Development
- Promoting a National Agenda: The Role for NSF

PIs noted considerable progress in the institutionalization of stakeholder support, professional development, and aligned district policies. As noted throughout this report, however, the educational landscape in which LSCs operate provides shaky ground: budgets shrink, priorities shift, and turnover occurs. All of these barriers influence districts’ capacity and willingness to support the staffing, organizational structures, policies, partnerships, and resources needed for sustaining the LSC vision for mathematics and science programs. In short, institutionalization remains an elusive goal—unpredictable over time. The following sections look at both the successes and challenges LSCs have encountered in trying to ensure the sustainability of their reforms.

Capacity and Infrastructure to Sustain LSC Professional Development

- *New Vision, New Leaders*
- *Organizational Structures*

LSCs prompted districts to expand their vision of professional development to one that encompasses ongoing opportunities for teachers to hone their knowledge and skills. An “institutionalization” composite for professional development was created based on PI and evaluator data on items such as the extent to which districts have structures in place for assessing teachers’ needs and use staff development days for mathematics/science professional development. Scores on this composite indicate that projects in their Final Year had a greater likelihood of LSC-type activities continuing beyond the grant than did projects in their Baseline Year. (See Figure 12.) Similarly, the majority of PIs of ending projects interviewed by HRI cited the continuing availability of post-LSC professional growth opportunities, although these activities were typically much reduced in scope.
New Vision, New Leaders

PIs and evaluators noted that LSCs laid the foundation for institutionalizing high quality professional development by changing the district culture and expectations around staff development. Some reported that teachers and administrators now expect coherent, participatory, and ongoing professional development programs, and that these expectations have led to new demands for continuing high quality activities. Said one PI from a project that had transitioned from LSC-funded professional development to a fee-for-service structure supported by 34 districts:

[The LSC brought about] a change, a shift in the culture from teacher training to continuous improvement—that this isn’t about getting trained to use the kits. This is about thinking about teaching and thinking collaboratively with your colleagues…[The LSC helped districts] to recognize the need to move beyond a short-term emphasis to a long-term vision that encourages collegiality and networking among teachers. (PI, elementary science LSC)

A new vision for professional development, while necessary, is not sufficient for delivering ongoing opportunities for professional growth as envisioned by the LSCs. In the eyes of both PIs and evaluators, one of the most essential pieces for sustaining professional development is the cadre of teacher leaders that LSCs leave behind. Said one evaluator on the significant roles played by these leaders in a large urban district, where district administrators had foiled every attempt to implement the LSC: “If IMP and the LSC reforms are to continue and to grow [here], it will almost certainly be due to the knowledge and commitment of this group.”
PIs of ending LSCs had come to the same conclusion. In their Final Year, over half of the PIs interviewed by HRI cited the development of teacher leaders as one of their greatest achievements. Said these project leaders:

[The teacher leaders] are the main way the LSC vision is maintained. [The LSC] was the vehicle for their development and their commitment and their vision. Those things weren’t realized on the system-wide level, but they were absolutely realized at the grassroots level. We created a solid core of well-trained, highly skilled teachers who can provide professional development. (PI, secondary mathematics LSC)

That grassroots movement has sustained us through the loss of central office staff. It helps buffer changes in the central office. Empowering teachers is a key piece of this, building their capacity as advocates. (PI, elementary science LSC)

Evaluators and PIs cited numerous examples in which groups of teacher leaders continue to meet, reflect on, and plan strategies for sustaining reform in their schools and districts. LSCs typically left these leaders with a sense of “connection and purpose” that fostered their continuing commitment, and a “collective way” to think about supporting each other and LSC reforms beyond the grant. Teachers on special assignment and school-based teacher leaders assumed active roles on school, district, and statewide committees during the LSC, and many continue in these roles after the grant, maintaining a voice for reform with other teachers and administrators. Said one evaluator: “[The teacher leaders] are a dynamic group that is likely to influence policies and practices for years to come.” In the words of another evaluator, teacher leaders “remain the best hope for institutionalization.”

PIs and evaluators frequently noted examples of the teacher leadership capacity that remains in the districts, and the implications for sustaining professional development and curriculum reform:

[The LSC helped] build district capacity for reform by developing large staffs of well-trained teachers in each target district. These cadres include teachers who are capable of providing professional development, revising curriculum effectively, mentoring new teachers, establishing science study teams, implementing extended school-day programs in science, and coaching experienced teachers. (Evaluator, elementary science LSC)

The districts are beginning to realize that they have a treasure trove of well-trained teachers who can help them sustain the growth of the project...I think this is where we’re going to have some lasting effects, is in these people who have really grabbed on to it and become, in the true sense, leaders. (PI, secondary mathematics LSC)

Through [the LSC], as well as the earlier [project], the districts have developed a cadre of teachers who embrace the project’s vision, can operationalize it in the classroom, and are interested in taking more of a leadership role for science program improvement. (Evaluator, elementary science LSC)
The [teacher] leaders in math education hold a unique position within the [district]. They stand poised to move the district’s math achievement beyond SAT 9-focused expectations. The knowledge and skills gained through their work with [the LSC] have given them a level of expertise not known within the district before….Their continuing presence is a major force in the long-term sustainability of the LSC reforms. (Evaluator, elementary mathematics LSC)

Anything that is continuing is due to what the lead teachers could or could not do. The stronger they are, the more things continue to happen. (PI, secondary mathematics LSC)

Invest in your leadership. These people are your best resource. Your leadership people continue and they are what will sustain you. Our 200 teacher leaders—they own the success. (PI, elementary mathematics/science LSC)

There was also evidence to suggest that districts, to varying levels, had bought into the need to sustain these leaders beyond the LSC grant. For example, one district had contracted with LSC-trained teacher leaders to provide professional development to every K–12 teacher after the grant. A large district had provided permanent funding for LSC teacher leader positions, resulting in “math coaches” released full-time in every school. Said the PI: “That is a structure the LSC put into place, and the district has copied it in all 97 buildings. That will not go away.”

Evaluators noted other examples of districts sustaining teacher leaders beyond the LSC grant:

- In an elementary mathematics/science LSC, the district will continue to support four positions formerly funded by the LSC around diversity, technology, and mathematics professional development.

- In an elementary science LSC, 13 of the 16 LSC districts picked up the cost for maintaining teacher leader positions formerly funded by the LSC; teacher leaders will assess needs, facilitate professional development, and assist with materials management.

- In a secondary mathematics LSC, district funds will continue to support teams of teacher leaders to assess needs and plan appropriate professional development. The “math team” provides input to the superintendent on curriculum, assessment, and professional development.

All of these examples suggest that LSCs—some more than others—were able to build a sense of appreciation for teacher leaders, and secure district support for their continuing roles as professional development providers. Other LSCs noted that, even without compensation, school-based teacher leaders would continue to provide support for their colleagues informally. Finally, evaluators and PIs noted examples in which the LSC model for sustained professional development had been adopted district-wide across subjects. Said this evaluator: “There is no higher recognition of success in professional development than this kind of imitation.”
Expanding the Leadership Capacity

“What’s probably most important is the fact that in each district at some point during the LSC, there have been one or two people who have the trust and respect of the superintendent and the rest of the administration to make decisions about mathematics and science. I can’t tell you how important that has been. To bring one or two people together, sit around the table and plan and have no one say, I need to check back. The LSC has built the capacity of individuals in the districts to take such leadership roles. It’s absolutely amazing. For example, one or two of the superintendents stopped coming to meetings and I was worried. I talked to people. They said what the superintendent has done is given someone else the power to make these decisions because he knows distributed leadership is really critical—so a [teacher on special assignment] now has the power to make these decisions. I know superintendents are very informed and very much behind it. It’s the flip side of they’re not coming to meetings. It’s not that they’re no longer interested. They know the project has built the leadership capacity of individuals—that it allows them to make these very important kinds of decisions.” (PI, elementary mathematics/science LSC)

Organizational Structures

While teacher leaders provide capacity, districts require additional scaffolding to ensure the institutionalization of high quality professional development programs. Policies can ensure participation, but structures are also needed to provide vehicles for delivery. Where LSCs made reform “part of doing business” in the district, opportunities for ongoing professional development stood a better chance of surviving beyond the grant. These evaluators provide examples where this occurred:

Changes in the [district office of operations] were key. This division is responsible for supervising and supporting the elementary school principals and in the past have seen themselves as being involved in only operations [and] not curriculum improvement. District administrators believe that the new direction of the elementary division is an indicator that the system is aligning itself to impact students and that this institutional structure is a critical piece in sustaining and coordinating the professional development for principals and teachers. (Evaluator, elementary science LSC)

The concept of regular, high quality professional development in mathematics provided system-wide by the districts was new to [the district] when it was initiated in the first year of the LSC. Before that, professional development was a hit-and-miss situation, with teachers selecting their own activities for their own purposes. The consequence was a lack of consistency in curriculum and delivery of instruction from teacher to teacher, and school to school that has been eliminated with the introduction and institutionalization of a policy of district-supported, system-wide professional development.... The district’s commitment to continue grade-specific professional development when the NSF funding ends ensures the institutionalization of regular, quality professional development for mathematics teachers. (Evaluator, K–12 mathematics LSC)

The project is tied to the school district and must operate within its goals and processes. This tends to slow the project down some and requires the project to achieve its goals through somewhat less direct methods than if the project were external. On the other
hand, this closeness with the district fosters and almost guarantees institutionalization of the project’s accomplishments. For example, the project is offering some of its professional development at the districts’ required in-service training. This somewhat limits what can be offered, but at the same time moves science up in importance in the minds of the teachers and the district administrators. The project is also working with the district’s existing mentor teacher program to ensure that these teachers value and understand science. (Evaluator, elementary science LSC)

To be sure, LSCs’ success in these efforts varied widely. Some faced fierce opposition in the policy arena. Reductions in staff development days available for mathematics or science, state professional development funds linked to the adoption of instructional materials that were not well aligned with the LSC vision, certification requirements for professional development providers which conflicted with LSC site-based strategies, “permission” to use state professional development funds to meet other pressing needs, the loss of Eisenhower grants dedicated to mathematics and science—all of these policies deterred LSCs in their efforts to institutionalize ongoing professional development for teachers.

Still, evaluators noted major successes, as projects took tangible steps to “hand off the organizational components” of LSC professional development to a district or a coalition of districts. Examples of LSC-initiated structures that remain in place for sustaining ongoing professional development included the following:

- In a K–12 mathematics LSC, district-supported “Learning Walks” by principals initiated under the LSC provide an ongoing mechanism for monitoring classroom instruction and gauging teacher needs. Project staff developed checklists and ratings to help with this process, so that principals can make informed recommendations on teacher professional development needs.

- School-based case study teams created as part of an elementary science LSC took a “substantial step toward showing schools a mechanism that supports teachers’ reflection on their practice.”

- In an elementary mathematics/science LSC, the district adopted the LSC Special Presenter model that enables mathematics and science teachers to attend grade-level professional development during the school day. Said the PI: “It’s excellent professional development, a big chunk of time in the school setting, designed for that school, in a professional manner.”

- A five-week summer school academy initiated by an elementary science LSC and now fully supported by the district ensures a “continual professional development model that allows teachers to grow as professionals and develop skills and knowledge based on their needs.”

- Numerous LSCs successfully moved from NSF-funded professional development to a fee-for-service structure, with the district paying for professional development provided by universities and non-profit organizations.
Among the most important structures initiated by LSCs were those to ensure professional development for teachers new to the instructional materials. Said one PI: “By continuing to provide first-use training, you make sure that your program doesn’t go away. If the program is based on kits, and if your teachers turn over, unless you acquaint new teachers with the science program, they may not know it exists, or they may be uncomfortable. We’re convinced that that’s the most important work we do.” In another LSC, five districts had jointly established and funded a beginning teacher program to ensure training for new hires. Other evaluators noted cases in which urban districts with high rates of turnover had institutionalized beginning teacher institutes with district support. In some cases, LSCs successfully sought external funding to support new teacher orientation sessions and mentoring programs; other projects mandated school-year sessions for beginning teachers, and developed notebooks to support professional development for new teachers.

Evaluators and PIs provided other examples in which LSCs had influenced districts to support ongoing professional development. In one urban district, for example, more strategic planning and coordination across central office departments resulted in a “shift” that provides stronger support for sustained professional development for both teachers and principals. A few LSCs had successfully pushed for mandatory professional development for teachers. For example, one PI noted that districts now require three hours of professional development a month as part of the teacher’s contract. In another project involving multiple districts, an LSC-trained Teacher-in-Residence continues to conduct post-grant mandatory 6–10 hour in-service sessions in science each year. Said the PI:

I view that as a very positive development, and that’s what will sustain it. We’ve developed a “steady state” program that will address the needs of teachers at all levels. We’ve got a program now. Before the LSC, professional development was something here and something there, and science was not a target. Now at least teachers have some commitment to professional development in science each year. (PI, elementary science LSC)

Still, major challenges stand in the way of sustained, high quality professional growth experiences for teachers in LSC districts. On the whole, participation remains largely voluntary. Some districts mandated that teachers participate in training in order to receive the designated instructional materials, but these policies did not ensure ongoing participation over time to enhance content and pedagogical skills.

Rarely were there formal district plans, structures, or teacher incentives to support participation in ongoing professional development beyond the grant. For example, the lack of stipends to support LSC-initiated action research groups in one district would likely mean the demise of these activities. Said these evaluators about their concerns for the institutionalization of high quality professional development, particularly at the school level:

District-wide structures that support implementation of standards-based instruction on campuses and meaningful teacher collaboration have not been developed. (Evaluator, elementary mathematics LSC)
With fewer professional development sessions planned for 1999–2000, the lack of time and opportunities provided at the school level for teachers to meet and plan during the school day becomes a more serious obstacle to reform than it has been in the past. (Evaluator, K–12 mathematics LSC)

Both the lack of after-school and out-of-school time for professional development is an issue that is highlighted in many evaluation initiatives in [the state], not limited to the LSC. If the LSC hopes for institutionalization beyond the end of the project, teachers and school administrators must be aided in finding ways to balance the demands upon teacher time. Those initiatives that survive will be those that become a part of a coherent model of school and classroom instructional improvement. (Evaluator, elementary science LSC)

Districts and schools need to reconsider school schedules and find or “make” time (that is compensated) for teacher collaboration outside of class time. The lack of commitment to a continuing program for professional learning for teachers is of concern. (Evaluator, elementary science LSC)

Finally, the reliance on external funds suggests the tenuous nature of efforts to sustain professional development structures. Many LSC districts are financially “strapped” urban and rural school systems with “multiple areas of weakness.” While they were willing to increase their focus on mathematics and science in exchange for additional resources, many districts will surely require supplementary resources to sustain reform efforts. Department of Education and NSF grants, Eisenhower funds, state professional development funds, private foundations, science-rich institutions, businesses, and others were supporting ongoing professional development activities. The challenges in convincing districts to allocate funds for continuing staff development were widely apparent, however. As the LSCs ended, some states were facing enormous budget crises. Said one PI: “It’s a huge reminder that economics still runs the way decisions are made. We’re at the mercy of those kinds of processes in the system. And continuing professional development is one of the first things to go.”


- **Mathematics and Science: A New Status**
- **The Adoption of Frameworks and Instructional Materials**
- **Assessment Policies: Barriers and Opportunities**
- **Competing Priorities, Policies on the Move**
- **Institutionalizing Policies**

Aligning policies and practices with the LSC vision for teaching and learning is part of the LSC mission, and PIs and evaluators noted major successes in this area, as well as huge barriers. For example, state and district policies that conflicted with the LSC vision worked against the institutionalization of reform efforts. On the other hand, aligned policies pushed districts in the “right” direction. The best-case scenario was the convergence of supportive state policies, particularly in the area of testing, with the LSC vision for teaching and learning. Few PIs
realized the impact policy would have on their projects. Said one: “What I have learned is the incredible power of policy—both good and bad. I wish I had known more about that early on. It’s far more important to work at that level.”

A composite on policy alignment, including items such as how curriculum frameworks, district and state assessments and teacher evaluations each impact the LSC reforms, indicates that projects in their Final Year were more likely than projects in their Baseline Year to be operating in a policy-friendly environment for the LSC vision for mathematics and science education over the life of the grant. (See Figure 13.)

![Composite: Alignment of District Policies with the LSC Vision*](image)

* Composite score for Final Year projects significantly different than the score for Baseline Year projects, p < 0.05.

**Figure 13**

**Mathematics and Science: A New Status**
LSCs made vast progress in moving mathematics and science to the forefront. Of the 35 PIs of ending projects interviewed by HRI, 30 noted that mathematics/science was now a high priority in the districts, compared to 11 who stated these subjects were a pre-LSC priority. PIs admitted that mathematics often had high status prior to the LSC, primarily due to state assessments, but the vision for instruction differed considerably from that advocated by the LSC. As one PI said, “[It was] not a priority for doing the kind of mathematics we wanted.”

Evaluators provided numerous examples of LSCs’ success in elevating the status of mathematics and science, in aligning policies and procedures, and in pushing districts to take responsibility for sustaining these changes. For example:

*Everyone is* speaking the same language. *Everyone understands the science agenda and is making sure schools are paying attention to it…. Now that took a long time to
create, and we are constantly working on keeping it going, but it is a powerful piece, or place where we are as a district. We think of ourselves as a coordinated system, serving the schools...and that is a whole different way that this system has aligned itself.

(Evaluator, elementary science LSC, quoting a district administrator)

There is tremendous alignment of policies and practices in support of the work of [the LSC]. There is also widespread knowledge of and buy-in into the vision for mathematics education among and beyond the [public school] community. [LSC] staff...have worked effectively over the course of the project to ensure this is a systemic effort, impacting policies and stakeholders, and not simply a quality professional development effort.

(Evaluator, K–12 mathematics LSC)

For me, the most important thing about what [the LSC] has been able to do over the years is to get science for elementary kids on the docket, the time devoted to science and then the quality of engagement. Ten years ago, I look back, and it wasn’t there...[Science] is no longer a set-aside and it is not on the whim of curricular adoptions, kind of how the state used to be—oh, it is a science year. Every year is a science year for us and [now] it continues to be at the center.... It is embedded now in the culture. You have to pay attention to it.

(Teacher, elementary science LSC)

Everything is starting to come together...across the district, mathematics is getting more attention. Everyone is finally on the same page. (Teacher, K–12 mathematics LSC)

When [the LSC] came along, it was almost like an abdication [for the district], like okay, [the LSC] will take care of our science for us, and over the years, it has evolved to where now you can see the district starting to take over again the responsibility of where they are going in science...to having formal procedures and policies around science in the districts and they continue to support those sites that aren’t participating in [the LSC] right now. They continue to support lead teachers, they continue to have district-wide meetings and talk about the direction they want to go as a district in science...That change has occurred in probably the last year and a half, two years. It has been the result of us having a dialogue with the district. (Staff Member, elementary science LSC)

A key indicator of districts’ shift in “mindset” was their inclination to modify teacher hiring and evaluation procedures to reflect the LSC vision for teaching and learning. In one district, for example, the district revised its criteria for evaluating teachers to align expectations with inquiry-based teaching practices and materials, and based hiring decisions on applicants’ knowledge and experience with “reform math.” Similarly, other LSCs gave hiring preference to teachers who had participated in LSC professional development. Said this evaluator:

One aspect of administrative policy and practice that has been strongly influenced by the [LSC] is the process districts follow in reviewing applications for teaching positions. This has been an unintended and exciting consequence and again, reflects the potent changes in the ways that individuals are thinking about instruction and learning. Districts are reconsidering the qualities they want in teachers. One person described what her district now looks for in new hires: We ask what they know about inquiry-based
other: The style of questions for new teachers has changed. “Are you familiar with the [state] benchmarks?” “Are you comfortable with a classroom that is not quiet”? “How would you feel if a student asked you a question and you didn’t know the answer?”…This is especially an encouraging effect of the [LSC] and illustrates how deeply the philosophy has seeped into the culture of the four districts.

(Evaluator, elementary mathematics/science LSC)

Other PIs noted that, while the LSCs had had some influence on districts’ views of mathematics and science as priorities, policies well beyond their control were often the major determinant in these changes. For example, in one LSC, the PI noted that, the priority status of science was most likely due to a new policy to disclose test scores—“an enormous motivating force.” In another district, mathematics had always been tested (and was therefore a district priority prior to the LSC), but new district “report cards” adopted just prior to the LSC applied greater pressure to improve mathematics instruction. In these cases, LSCs found themselves well positioned to push a new vision for instruction, or to provide an alternative voice in the face of more conservative policies. Said this PI:

When it became clear that the policies were not going away, districts said we have to do something about our mathematics program, and that’s where the LSC came in. In an emergency setting, districts are quite ready to gravitate toward what they think will help them out…. Mathematics is a high priority now, partly because of the standards and partly because it’s first to be tested. The priority status probably comes less from the LSC than from external factors, but the solution as to how they deal with the external factors, we can take some credit for. (PI, secondary mathematics LSC)

In the case above, the LSC played a critical role—pushing for “exemplary” materials and standards-based instruction, and clarifying ways in which the materials could “deliver” in terms of addressing policies. Other PIs reported similar circumstances that “forced” districts to embrace new priorities—where “people were looking for something” to help them meet new standards and improve test scores. Said one district administrator: “It all merges together. You can’t say what drove what. The LSC just came around at the right time. Mathematics was a priority before. Now it’s a high priority.”

The Adoption of Frameworks and Instructional Materials
When PIs describe frameworks and instructional materials in the districts prior to the LSC, they use terms like “mish-mash,” “fragmented,” “rag-tag,” “in shambles,” and “horrendous.” Districts often had no frameworks in mathematics or science, or were using twenty-year-old teacher guides. Said one PI: “The pattern was that teachers would get together and select a textbook for the next year, take the table of contents and develop a ‘framework.’” Few of the instructional materials that teachers were using in their classes before the LSC could be called “exemplary.”

The LSCs substantially changed these practices, using the development of frameworks and the selection of instructional materials as vehicles for aligning curriculum and developing ownership of reform. PIs described a materials selection process that was highly inclusive; some invited “friends and enemies” to review and select from a range of materials—from the most
conservative to the most progressive. LSC staff and teacher leaders were typically well-represented on committees to develop new guidelines, review materials, and pilot modules aligned with frameworks and standards. In K–12 LSCs, the development of frameworks helped promote a more coherent curriculum, with articulation across grade levels. LSCs also assisted in the development of matrices, performance objectives, and benchmarks to guide current and future instructional materials adoptions.

In part, LSCs were able to “ride the crest of the standards movement,” and evaluators and PIs reported major successes in this arena. For example, 28 PIs out of 35 ending LSCs noted that districts now have aligned frameworks, and virtually all of these PIs expected future revisions to these documents to reflect the LSC vision. Further, in 26 of these projects, districts had formally adopted the designated materials and budgeted funds for their purchase, typically early in the life of the LSC and sometimes in an extremely hostile political environment. Evaluators reported numerous examples in which the designated LSC materials had become synonymous with the mathematics or science program in the district. Said one evaluator: “The fact that every teacher in the district was using FOSS at the end of the LSC speaks to the classroom institutionalization of the curriculum.” Still, some PIs were reluctant to give the LSCs all of the credit for district adoptions of new frameworks, noting that national and state standards-based reform efforts were occurring simultaneously.

**Institutionalizing Curriculum Programs Guided by the LSC Vision**

In a K–5 mathematics LSC, the project overhauled the entire elementary program, putting in place a new curriculum guide aligned with the NCTM standards. The guide identifies mathematics content and processes for each grade, and is widely accepted in every school, with teachers no longer asking “Why are we doing this?” and “Why don’t we go back to the old way?” Said the PI: “The LSC achieved widespread acceptance of the notion that mathematics is not show and tell. It’s a different view of instruction, across the board…Our goal was always to be the mathematics program in the [city] schools. That’s been a major success. Some still talk about the [LSC] project, but two years ago we started to call it the [city] mathematics program. Now that’s set in place.”

LSCs that encountered difficulties in aligning frameworks and adopting “exemplary” materials typically ran up against state policies that were not well aligned with the project’s vision. In some cases, dual adoptions of textbooks and inquiry-oriented materials sent mixed messages to teachers and administrators, resulting in fragmented instruction and fewer funds for purchasing modules. In other LSCs, districts adopted frameworks, materials, and a professional development program aligned with the LSC vision, but new state guidelines limited choices for future adoptions and tied state staff development funds to district adoptions, thereby threatening more progressive local policies. Small systems were particularly strapped when it came to adopting and purchasing materials; some did so slowly, over time, to make the process affordable, but according to some PIs, the prohibitive cost was sure to be a deterrent in institutionalizing the adoption and use of the materials.
Still, it would appear that LSCs played a critical role in aligning frameworks, instructional materials, and professional development in participating districts. Further, evaluators and PIs cited materials management centers initiated under the LSC as one of the great successes of the program, describing systems that were “highly sophisticated,” efficient, responsive to teacher feedback, and essential to sustainability. Typically, these centers fully transitioned into a fee-for-service structure by the end of NSF funding. Additional districts, beyond those originally participating in the LSC, were recruited to help cover the cost of staffing, refurbishment, and delivery through a regional, district-based, or university-based center. In some cases, LSCs carefully monitored returned science kits to determine teacher use, gaps, and needs for professional development and one-on-one assistance. HRI interviews with PIs of ending LSCs named materials management as one of their “bright lights:” 15 of the 18 science projects currently have a center in place—more than double the number that had a system prior to the LSC—and PIs described these systems as well-institutionalized.

Assessment Policies: Barriers and Opportunities

By all accounts, assessment policies were a huge issue for LSCs. “It drives instruction,” said one PI, “for better or for worse.” On the positive side, state and district assessments ensure that mathematics and/or science will be taught. Even poorly aligned tests had their benefits: they made these subjects instructional priorities. On the other hand, as noted earlier, assessments could be a “persistent hindrance,” diverting teachers from using the LSC-designated instructional materials and inquiry-based practices. Assessments prompted administrators to “care” about mathematics and science, but the unaligned nature of most tests led them to care about “the wrong thing.”

Where LSCs were able to influence districts to adopt aligned assessments, evaluators expressed hope for a “self-reinforcing system of instruction and assessment,” and there was some evidence to suggest that LSCs had made progress in these endeavors. For example, due to the lack of alignment of state tests, a few LSCs developed assessments aligned with the designated materials; in some cases, these assessments are fully sanctioned by the districts and reported district-wide as part of multiple measures. According to some PIs, aligning assessments with the materials was crucial for any continuing hope of institutionalizing LSC curriculum efforts. Said this PI:

-One thing that moved the LSC forward is the fact that we have had district standards-based assessments since 1996...Having things aligned made life much easier. When people ask, “What can I do to improve test scores?” we can say, teach the adopted program.... We would not have lasted if assessments were not aligned with the materials. It’s really critical. (PI, K–12 mathematics LSC)

Where assessments were not well aligned with the modules, LSCs “jumped hoops” looking for ways to communicate to teachers the ways in which the designated materials met state requirements. Some LSCs developed tools—written guides, sample test items—that linked materials and methods to state or local performance standards. Others encouraged professional development providers to help teachers interpret and use test results to improve students’ weaker content areas. One LSC sought to develop science assessment instruments that emphasized mathematics and language arts. In another project, LSC staff linked instructional materials in
physical science to learning targets in mathematics, reading, writing, and communications. Evaluators also provided these examples in which LSCs tried to work within the constraints of assessment policies:

The LSC has offer[ed] workshops for teachers and principals on curriculum integration, interpreting SAT 9 scores, and aligning curricular modules with the [state] Course of Study and the SATs. Structurally, the project has encouraged districts to hold district council meetings for principals and teacher teams from each school to have a forum for addressing programmatic and instructional concerns. (Evaluator, elementary science LSC)

District and school administrators, and [the LSC] seminars communicated the clear message that teachers who were implementing reform mathematics instruction were preparing their students to meet the requirements of the state test. (Evaluator, K–12 mathematics LSC)

The [LSC] took several approaches to allay [teachers’ test] anxiety…by designing professional development activities to examine [state test] items related to the standards-based curriculum. (Evaluator, elementary mathematics LSC)

Still, faced with immense barriers, LSCs struggled in the area of assessment. In some states, student performance in mathematics was linked to graduation, teacher pay, school funding, and state control of “failing” schools. These issues have “put pressure on the system” and “increased the anxiety and…focus on school test results.” Said one PI: “All of that is outside the ability of our department to influence—it’s political and financial issues at the state level.” In fact, few LSCs were able to exert much influence on assessment policies, instead choosing to work “behind the scenes” to ensure that assessments did not sabotage teachers’ use of designated instructional materials. But, in the words of one PI, the “constant pressure of the state, the press, and now federal legislation has made this increasingly difficult.” Said these PIs and evaluators about these challenges:

The target was always moving in terms of the test, and we didn’t know where the state was going to go, and it’s still moving. Superintendents and teachers have to perform on the tests, and at times, they didn’t have enough buy-in to the LSC to believe that what they were doing was actually going to be good for kids. (PI, secondary mathematics LSC)

Political and financial variables drive instruction toward political and financial outcomes. It was a constant battle to get away from that…Reform in science faces an uphill battle. Language arts are a priority and the importance placed on science instruction has diminished under pressure from state testing in math, reading, and written communication…State tests have damaged the focus on standards-based instruction. (PI, elementary mathematics/science LSC)

[It’s the] good news, bad news thing. We never would have sold everybody on all this science if we hadn’t had state testing. If the state says all we’re testing is reading,
writing and math, which they did propose this year, we said to ourselves, Okay, there
goes our program. That would have happened. That’s how much those tests count. And
had the testing been contradictory to our vision, we would have been in real trouble. (PI,
elementary science LSC)

At the state level, conflicting interests also stymie support for LSC reforms…and run
almost contrary to most of [the LSC] goals. The emphasis on accountability based on
scores on the SAT 9…has districts and teachers confused about what is appropriate to
teach….Without a clear directive from the state and/or district to teach meaningful
mathematics in the manner presented by the LSC project, teachers, principals, and the
project staff are challenged to reconcile these disparate approaches. (Evaluator,
elementary mathematics LSC)

State and district assessment policies also drove low performing schools away from LSC
reforms, and created an extreme imbalance between mathematics and science instruction,
particularly in the elementary grades. One PI reported that each year more and more science kits
were returned unused, as principals mandated teachers to “move away from science” to bring up
test results in mathematics and reading. In short, the pressures exerted by testing in other
subjects reinforced the notion of science as the “underdog” in the day-to-day choices teachers
made.

Competing Priorities, Policies on the Move
As PIs consistently noted about their efforts to institutionalize a new vision for mathematics and
science instruction, LSCs play in a system that is both fragile and fickle. Said one PI: “Things
come and go. Districts will hook up with something new…If the [state test] results are good, and
if we can perpetuate the training, it’s here for a while.” Where the LSC was consistent with and
integrated into district policies—teacher evaluation, school improvement plans—and where clear
links were provided between what is taught and what is tested, institutionalization seemed
possible.

LSCs tried to broaden the scope of their work to better address competing district priorities,
expanding professional development to include a range of topics—for example, assessment,
technology applications, questioning for understanding, writing for comprehension—thereby
demonstrating to teachers that the skills they learned in LSC training could serve them well
across the curriculum. Some LSCs “highlighted the parallels” between inquiry-based science
teaching and learning, and problem-solving emphasized in the district mathematics curriculum.
Another LSC developed a writing component that emphasized student journaling in science.

However, even where LSCs made progress in aligning policies and increasing the status of
mathematics and science in the districts, “the burden of competing initiatives” worked against
sustaining this focus. For example, some PIs noted that, by the end of the LSC, districts were
ready to move their attention to other subjects and initiatives. Moreover, success could be a
double-edged sword: where LSCs had resulted in clear improvements, PIs hypothesized that
districts might be inclined to shift efforts away from mathematics or science to other subjects
that were lagging. This was particularly true for science—the less tested subject. These PIs
described the challenges this way:
In some ways we’ve reached a ceiling in the amount of time teachers can focus on science because of the other priorities in the districts. The impact is that a lot of resources and professional development are taken away from science to meet other demands. There’s a lot pulling on the sleeves of these districts, a lot of fads, so a new superintendent comes and says this is what I think we should do. (PI, elementary mathematics/science LSC)

As we came to the end [of the LSC], I felt a collective sigh of relief [from superintendents] that this was over, because we had been taking up so much of their staff development time, it was starting to grate on them. They were saying, Okay, we’ve done science, now it’s time to do something else. (PI, elementary science LSC)

The science program will have to compete with other instructional needs for both time and money. At the moment, the community and the central administration are comfortable with science. They now see elementary school science as a core subject area without any major problems. Unfortunately, this does not give science a competitive advantage in gaining resources. Presently, reading and mathematics are the “hot button” areas of the curriculum, as they are nation-wide. The district is currently funding efforts to remedy problems in reading and math. “The squeaky wheel gets the grease” is clearly the maxim in operation here. (PI, elementary science LSC)

The biggest challenge is the landscape of literacy and mathematics which have the highest priority of anything anywhere, and the idea that science takes a low priority to those, especially over the last two to three years. When we started, districts funded school-based facilitators [for science] in every school. When the grant ended, those positions were removed and replaced by facilitators for literacy and math. (PI, elementary science LSC)

One barrier to institutionalization is the concern of district administrators regarding the number of competing initiatives. There is pressure for change coming from multiple sources and the teachers have a limited amount of time to work together. There are state initiatives and district initiatives…Science education is only one of many items that demand nonexistent funding. (PI, elementary science LSC)

LSCs that successfully dealt with these competing initiatives cited the use of data as an important strategy for making their case with stakeholders. Said one PI: “We have data that shows that science can be used to improve language skills. That’s a strong lever and one of the things that definitely helps convince the district.”

Shifting policies, however, could readily steer districts away from the LSC vision. For example, in one state, the legislature was challenging state standards aligned with the LSC; given that many districts had bought into the project precisely because the designated materials were well-matched with state guidelines, the PI was pessimistic about the future of reform if the legislature successfully ousted the standards, noting that, “If the naysayers win at the political level, it’s going to be big trouble for mathematics…If the standards go out, all bets are off.” Similarly,
another PI commented on the impact of shifting national policies: “This ‘No Child Left Behind’ federal testing has sent the state into an uproar. So we’re aligned with everything right now in the state, but if the state does something procedural, they will pitch this [curriculum guide] in a minute.”

Even PIs who had been able to sustain district support for mathematics and science spoke of the challenges of working in an environment over which they have little control. For example, said one PI about the fragile state of the district’s materials management system, due to a proposed tax cap which would have eliminated the center: “We could have lost everything. So yes, it’s institutionalized. It’s over thirty years old. It is how we think science should be taught, but it’s always at the whim of state or municipal funding.”

Within this vacillating policy environment, reform leaders accomplished much, however. PIs and evaluators commented on the crucial role that LSCs played in keeping attention on mathematics and science, even “when it was real easy to get rid of [them].” Said these PIs about progress, setbacks, and the need for constant vigilance:

> Understand that it will take more time, money, and effort than you ever anticipated. (PI, elementary mathematics LSC)

> There are so many factors over which we have absolutely no control, so we have to just keep maneuvering to keep things going… For every step you take forward, you take three quarters of a step backwards and just keep moving. (PI, elementary science LSC)

> We have to continue to do what we’re doing. If we were to sit on our laurels, within a year or two we’d have a bunch of new teachers without training, and it would fall apart in a few years. And it would be like it was never here. So it needs to be constantly looked after. (PI, elementary science LSC)

PIs also emphasized the need for forward-thinking strategies: setting an “institutionalization” agenda from the outset. Said one PI on the importance of doing so: “When you sit down and outline a project, the mood is upbeat, and you tend not to want to face difficult issues. It’s important to design right up front a way that districts will convert what resources they have into sustainable resources…It’s not how many years do we have to provide x, y, and z. The conversation has to be around how we sustain this over a long period of time right from the start.”

In reality, PIs often lacked the time, experience, or vision for building these kinds of activities into the project design. Frequently, the bulk of effort was devoted to managing the project, implementing professional development, and supporting teachers. Thus, while some PIs advised knowing what the system will bear, leveraging support, and building in “transitioning” mechanisms, others admitted to not having a real sense of the level of work required, and “over-committing” designated staff and district personnel in LSC proposals. In some cases, LSCs’ limited understanding of the tasks, roles, and level of commitment needed to accomplish their goals had huge implications for moving beyond teacher enhancement—to systemic reform and the institutionalization of policies and practices needed to sustain LSC activities.
Institutionalizing Policies
The LSCs appear to be making progress in aligning district policies and practices with the reform vision as evidenced by the higher composite scores for Final Year projects than for Baseline Year projects (Figure 14). A similar pattern is evident when PIs and evaluators are asked to predict the likelihood of these systems remaining aligned after the LSC grant ends. No significant backsliding is expected, suggesting the continued alignment of supportive policies—institutionalized, in part, due to the LSCs’ efforts.

![Composite: Existence of Systems to Maintain Alignment of District Policies with the LSC Vision*](image)

* Composite score for Final Year projects significantly different than the score for Baseline Year projects, p < 0.05.

Figure 14

Promoting a National Agenda: The Role for NSF

NSF, through the LSC initiative, provided districts with access to resources, expertise, information, and collaborative opportunities—all of which proved highly valuable to LSCs in their efforts. Said one PI: “[NSF] shouldn’t underestimate the role they play. It’s not just support, but also guidance. This is all such new territory.”

PIs interviewed by HRI also noted several areas where NSF might expand their role. In particular, project leaders believed that the Foundation could assume a more visible role in supporting reform—both at the national level and in the districts. For example, PIs noted the need for a national public relations campaign to promote high quality mathematics and science programs, as well as more definitive support from NSF to counter opposition. Specifically, one PI from a K–12 mathematics LSC suggested developing a “message about why this is important mathematically” and “the qualities in programs that work,” using prominent mathematicians with high credibility in the mathematics community to provide arguments in support of NSF
materials. In short, NSF should be more “visibly out front.” Said one PI: “When the rubber hit the road, the response from NSF was muted….[They needed to be saying], ‘This is the NRC. This is NSF. We believe everyone is entitled to a high quality mathematics education. We believe the best way to get that is experiencing mathematics and understanding it.’”

In addition to increasing their role nationally, PIs suggested greater visibility in the districts, noting that NSF might play a stronger role in holding local stakeholders accountable for supporting reform. For example, NSF conversations with superintendents early and midway through the LSC could help ensure that key administrators understand their role in providing tangible support for the LSC vision and goals. Said one PI about a visit by an NSF program officer to LSC schools and the superintendent: “We got a lot of mileage out of that visit. I think a stronger presence by NSF, even if it’s just a visit, goes a long way to helping promote what they do. There’s a certain amount of prestige to getting the grant. It’s good for them to reinforce that.” Added another PI about the impact of even small gestures by NSF:

As these grants come to a close, if there were a way that NSF could even do something with a letter, complimenting districts on their efforts. Districts can use that with parents to continue their efforts, saying, look we’ve got some national recognition. They can use it in their media, and can say we want to expand… That would help administrators and lead teachers and give recognition for all the work they’ve been doing under the grant. Sometimes just encouragement is important for sustainability. (PI, secondary mathematics LSC)

According to PIs, NSF also has a key role to play in the area of research, development, and dissemination. PIs cited the need for high quality professional development materials—for both classroom teachers and teacher leaders—thereby alleviating projects of the pressure to develop their own. PIs noted the need for NSF to assume a similar role in the area of assessment—in supporting the development of appropriate assessments, in advocating for their use, and in providing some balance in the accountability debates. Said these PIs:

It would have been very helpful if we had access to assessment tools that we could use in our LSCs. HRI did a good service and it is very convincing to a lot of stakeholders. We need access to tools that will generate the right kind of data—that is aligned with what we’re doing. NSF could provide greater access. Like, why did we have to spend an incredible amount of money developing these tasks? There could be a bank out there somewhere. (PI, elementary mathematics/science LSC)

NSF has a hands-off approach…[but] there’s not enough evidence out there. We all have to find a way to demonstrate that this kind of science improves kids’ knowledge and skills more than sitting around all day with the textbook. (PI, elementary science LSC)

Finally, PIs suggested that NSF continue to encourage LSCs to attend to policy and stakeholder support. At the same time, there has to be recognition of the need for more resources to devote to these efforts. For example, PIs believed that NSF (and LSCs) misjudged the significant roles principals play in reform efforts, as well as the level of effort required for engaging these administrators (and others) as fully and effectively as needed. Said one PI: “This is not just
about getting teachers educated or retrained. It’s about parents, other teachers, other disciplines, and other administrators. People need to think in a much broader capacity than just providing professional development to teachers. The change process is complex.”

Reform is also slower than PIs anticipated, requiring every bit of 10 years to institutionalize the changes initiated under the LSC. Said one PI: “You can get the curriculum there, but if you don’t have five years to deepen it, you’re working against the odds.” According to some PIs, NSF seriously underestimated the amount of time and support LSCs needed to accomplish their mission—not only in the area of systemic change, but also in terms of teacher enhancement. Said one PI: “The challenges for teachers are tremendous in terms of overcoming all the beliefs they have about teaching, to look carefully at what they’re doing, to let kids struggle with the mathematics. It’s a long, long, long process.”

PIs maintained, however, that the message of systemic reform from NSF must remain strong and consistent. Said one: “The federal commitment is powerful. You get all these fringe groups talking, working against sustained reform. NSF has to keep telling people: This is systemic. This takes time. And you’ve got to deal with the whole system.”
HIGHLIGHTS: Institutionalization of the LSC Vision and Reforms

Successes

LSCs made steady progress toward institutionalizing professional development over the course of the grant; further, PIs and evaluators predicted that these professional growth opportunities would be sustained beyond the LSC funding period.

LSCs leave behind a strong cadre of teacher leaders with the capacity for supporting ongoing, high quality professional development for classroom teachers.

LSCs leave in place district- and school-based structures to support professional development for new and experienced teachers.

LSCs helped propel mathematics and science to the forefront, with districts making commitments to support professional development, teacher leader positions, the adoption of standards-based instructional materials, materials management centers, and new hiring policies.

LSCs helped push policies and practices in support of aligned frameworks, high quality materials, and efficient materials management systems, and these remain solidly in place as LSC grants come to an end.

LSCs were well-positioned to promote their vision for mathematics and science instruction, and looked for ways to use this message to support state and district policies.

NSF provided resources, credibility, and clout that were critical in LSCs’ efforts to change policies and systems.

Challenges

Limited resources and capacity, lack of incentives for teachers to participate in professional development, and school-based constraints have hampered efforts to institutionalize LSC activities.

State testing mandates continue to plague LSCs’ efforts to institutionalize aligned professional development, curriculum, and assessment policies and practices.

Competing priorities and needs in other subjects continue to challenge sustained attention to high quality mathematics and science programs and professional development.

Conflicting national, state, and local policies pose a constant threat to the institutionalization of LSC reforms, even where projects have already had success in establishing supportive policies and structures.
LSCs had little time for, and experience in, conceptualizing a long-term, strategic plan for institutionalization; “hindsight” brought PIs a clearer understanding of the complexities and level of effort needed to sustain change beyond the grant.

Greater national and local visibility by NSF, as well as stronger support in the area of professional development materials and assessment, might have helped LSCs in their efforts to implement and sustain reforms.
Summary and Recommendations

Summary

- Building Capacity and Consistency Where Variability Is the Norm
- Communicating the Relevance and Value of Reform
- The Great Balancing Act
- Advancing Systemic Reform where Context Limits Control

Data from LSC core evaluation activities have yielded much information about the progress LSC projects have made, and the pitfalls they have encountered along the way. As expected, LSCs vary considerably in their design and strategies for improving mathematics and science education through teacher enhancement, yet common themes have also emerged over the course of the initiative. This section looks at some of these recurring themes, and their implications for LSC projects and the initiative as a whole.

Building Capacity and Consistency Where Variability Is the Norm
Evaluation data suggest that LSC efforts to build capacity have produced some important successes. Overall, LSCs have had a positive impact on teachers’ attitudes toward teaching mathematics and science, and their perceptions of preparedness in content and pedagogy. With increased participation in LSC professional development, teachers are more likely to use the designated materials, and the quality of their instruction improves. Still, the gap between teachers’ perceptions of their ability to use inquiry-based practices and materials, and their capacity for doing so, remains wide. In many cases, “emerging teacher knowledge” had yet to translate into high quality instruction. The fact that few teachers have participated in the full 130 hours of professional development has clear implications for the level of impact. Without sufficient exposure through LSC activities, and with limited classroom experience in using new materials and practices, many teachers had not achieved the “complex understanding” of content and pedagogy needed for implementing the materials well, and for making lessons both rigorous and engaging. More time, practice, and support will certainly be required for this to occur on a scale envisioned by the LSCs.

Where LSCs have excelled in building capacity lies in their teacher leadership. As reported by evaluators and PIs, the initiative has developed a solid core of teacher leaders, many of whom have played, and continue to play, integral roles in planning, designing, and implementing professional development, policy alignment efforts, and community outreach. By all reports, these leaders represent an essential piece of reform that LSCs leave in place to sustain their efforts. Yet LSCs also struggled with consistency and quality in using professional development providers whose skills and experience varied considerably. As with teachers, professional development providers need time to practice new behaviors and perfect new roles. Some providers received extensive preparation, while others were sent into the field with little training and support. Content and modeling/discussing inquiry-based practices continue to be weak areas for teacher leaders. Facilitation, coaching, and mentoring skills were often neglected by LSCs in preparing providers, diminishing the quality of school-based support. Few LSCs had the numbers of qualified teacher leaders needed to fully support teachers.
To be sure, LSCs made efforts to overcome these challenges, but with varying success. Recognizing the limitations of professional development providers and the inconsistency across sessions, LSCs teamed less experienced providers with “veterans,” and paired scientists/mathematicians with classroom-savvy teachers to better meet teacher needs. LSCs also extended the opportunities available to teacher leaders to enhance their skills, and developed tools—scripts, guidelines, notebooks—to lend some consistency to professional development offered by less experienced providers. In the end, however, LSCs were forced to trade off project needs—scaling up and reaching more teachers—with the needs of professional development providers, and sometimes quality was lost in the process.

**Communicating the Relevance and Value of Reform**

The ability of project leaders to communicate the benefits of reform to teachers and administrators has implications for participation, support, and sustainability. LSCs provided teachers with concrete experiences needed to implement new instructional materials—with practical and direct applications in the classroom—thereby increasing both the relevance and perceived value of participation. Further, consistently high ratings by evaluators suggest that projects have excelled at creating a professional development culture that is conducive to collaboration, dialogue, and reflection—activities highly valued by teachers who typically work in isolation.

LSCs have also tried to communicate the ways in which their vision for mathematics and science education supports state/district policies, contributes to improved student achievement, and adds value in other subjects. PIs and evaluators reported considerable success in moving mathematics and science to the forefront as district priorities, in securing a supportive policy environment for reforms, and in increasing stakeholder support over the course of the project. The widespread development of new mathematics and science frameworks and the adoption of high quality materials were clear indications of district-wide support for the LSC vision. Similarly, as proof of their recognition of the value of LSC reforms, districts made tangible commitments to sustain teacher leader positions, materials management systems, and professional development structures.

Still, the LSC vision for mathematics and science instruction often conflicts with entrenched views of teaching and learning. Pockets of resistance, superficial support by administrators, high stakes assessments, and literacy initiatives sometimes derailed LSCs’ efforts to keep attention focused on high quality mathematics and science programs, and the professional development needed to implement them.

**The Great Balancing Act**

LSCs face a host of dilemmas in their reform efforts, requiring project leaders to make difficult choices at every juncture. In providing professional development, for example, LSCs must balance attention to content, pedagogy, and materials. Projects continue to give their primary emphasis to familiarizing teachers with the designated instructional materials—typically using the modules as the basis for learning new content and pedagogy. With the scale tipped in favor of pedagogy and materials in professional development over the entire life of the project, content remains the underdog. This imbalance has clear implications for LSCs’ capacity for meeting teachers’ considerable content needs, particularly at the elementary level.
LSCs offered a range of professional development opportunities—from introductory to advanced—to meet teachers’ varying levels of readiness. Projects also sought to gauge teacher needs and adapt designs accordingly, providing a range of venues and formats, and balancing project-wide professional development with school-based support activities during implementation. These qualities remain a major strength of LSC projects. However, evaluators gave LSCs mixed reviews in a number of other areas that required a balanced approach—for example, tending to “what teachers need” versus “what teachers want.” Content sessions sometimes sacrificed rigor in the interest of maintaining high teacher “comfort” levels. And attention to broader (and deeper) conceptual or pedagogical themes was often lost to discussions on activities and logistics.

LSCs also encountered problems in balancing immediate project needs—providing professional development—with long-term goals, for example, engaging principals, parents, partners, and others important for sustaining reforms. Securing stakeholder support requires proactive leadership. It also requires staffing, resources, and strategic planning. LSCs were often “short” in these areas, recognizing the need, but “dropping the ball,” of necessity, to focus on support for teachers. Few LSCs had a consistent and long-range strategic plan for engaging administrators and other stakeholders at each level of the system.

Finally, LSCs continue to try to balance the needs of new teachers with those already implementing the modules. The large influx of teachers new to the districts, grade level, or curriculum required constant attention, diverting resources from professional development opportunities that might have deepened the level of use by teachers with some previous LSC experiences. In part, PIs and evaluators blamed this reoccurring problem for LSCs’ limited success in providing the full quota of professional development hours to all targeted teachers.

**Advancing Systemic Reform where Context Limits Control**

LSCs operate in systems with many components over which they have little control. As noted throughout this report, turnover of teaching and administrative staff continue to create major barriers to gaining and sustaining support for reform. Further, making time for teachers to attend professional development during and outside the school day remains a huge obstacle to full participation and commitment by teachers. Finally, poorly aligned assessments continued to be an enormous policy barrier, frustrating teachers and project staff alike. In the words of one PI, the LSCs’ main challenge “reflected the state of education and the national trend toward testing which are counter to what we know is good mathematics and science.” In short, the three “Ts”—turnover, time, and testing—challenged LSC efforts to sustain momentum, to embed professional development in the school culture, and to make the case for LSC materials. State policies on materials adoption—far beyond the control of the LSCs—also left teachers, administrators, and school systems with fewer options and conflicted choices.

LSCs sought to work within these constraints—adapting designs, strengthening site-based support, and working with teachers to overcome testing anxieties. Project leaders also sought to support relevant policies through the LSC—for example, in the areas of teacher hiring/certification/evaluation, literacy development, and graduation requirements. LSCs have created or built on existing ties to universities, businesses, and science-rich institutions to
provide professional development, materials management, and pre-service and in-service experiences for new and future teachers, and these partnerships have provided stability in a fluctuating system. Finally, project leaders sought to build administrative support through the creation of formal structures within the system, and in some cases, these structures successfully took on a life of their own.

PIs noted that the institutionalization of LSC reforms depends on the ability of projects to establish a strong foothold for change, and to secure resources for staffing and structures to support quality mathematics and science programs. LSCs have made admirable progress in these areas. Still, the end of LSC funding in districts typically results in a sharp reduction of opportunities for sustained professional growth experiences for teachers, suggesting districts’ limited will and capacity for supporting LSC activities. The lack of mathematics- and science-specific professional development requirements in many districts further implies that LSCs have far to go in changing the culture and system to embrace the need for ongoing, high quality programs to bolster teachers’ knowledge and skills.

**Recommendations**

- **Preparation and Support of Professional Development Providers**
- **Professional Development Programs**
- **Securing Administrative Support**
- **Planning for Sustainability**

The following recommendations reflect the challenges LSCs continue to encounter in their work with teachers and school systems.

**Preparation and Support of Professional Development Providers**
Large professional development projects such as the LSCs can expect to send professional development providers, especially teacher leaders, into the field before they are fully prepared. Strengthening ongoing support in recognized areas of need—content (module-based and beyond), explicit attention to pedagogy, skills needed to provide small group and individualized support to teachers, strategies for working with resistant teachers—can help better prepare these providers for their roles.

**Professional Development Programs**
A primary challenge for large-scale professional development projects lies in attracting teachers and sustaining their involvement so that they can receive the full dose of professional development. Projects should expect considerable difficulties in this area, and devise strategies and incentives to sustain teachers’ willingness to participate—for example, strengthening site-based opportunities, working with principals to support teacher participation, and pushing for critical mass at the school level. Projects might also devote a more equitable share of professional development time solely to content to better meet teachers’ needs in this area.

**Securing Administrative Support**
The commitment of principals remains critical for reform to take hold at the school level. Teacher enhancement projects can benefit from offering principal-specific workshops over time...
to reinforce the message. Given the high rates of turnover, projects also need a formal strategy for working with new principals. Reform efforts should expect a high level of effort in communicating their message to district administrators as well, and consider developing formal structures for communication and input that have the potential to outlive the grant and sustain reforms.

Planning for Sustainability
The level of effort required to implement large-scale professional development programs is far higher than LSCs anticipated. As a result, planning for sustainability often received limited attention. From the outset, reform efforts must engage stakeholders in discussions about long-range commitment to reform and maintain a systemic focus. NSF can help by alerting projects to the dilemmas and complexities of “doing” systemic reform; by providing access to knowledge, tools, and resources in the areas of curriculum, assessment, and professional development; and by using its clout and credibility to reinforce the reform message both nationally and locally.
APPENDIX
Appendix A  
Description of Core Evaluation Data  
Collection Activities and Data Used in This Report

While LSC projects are bound by goals and expectations set by NSF, they also must develop a strategy that is responsive to local context and needs. Although the result has been a set of LSC initiatives that range considerably in design and implementation strategies, the core evaluation system allows information to be aggregated across these diverse LSC projects. Project evaluators are asked to collect data using standardized questionnaires and protocols designed to answer core evaluation questions, and to complete ratings on the quality of LSC professional development programs. The quantitative data used for this report were drawn from each project’s last full year of data collection.\(^1\) Data collection activities completed by evaluators of each LSC project include the following:

- Observations of professional development activities;
- Classroom observations;
- Teacher questionnaires;
- Principal questionnaires;
- Teacher interviews; and
- Interviews with LSC Principal Investigators.

**Observations of Professional Development Activities**

The core evaluation requires evaluators to conduct observations of professional development sessions each year, and record their observations on standardized protocols. Established projects are asked to conduct 5–8 observations, while Baseline Year projects conduct at least 2 observations. Evaluators are to consult with LSC PIs on the professional development activities planned throughout the year, and select a sample that is representative of the range of experiences offered. A total of 442 observations of professional development sessions were analyzed for this report; data were weighted to control for the variable number of observations conducted per project.

**Classroom Observations**

HRI provided the lead evaluator in each project with a list of randomly selected teachers for each targeted subject. These teachers, or their randomly selected back-ups, were to be observed in the spring, initially at the beginning, midway, and end of the project. A total of 1,054 lessons were analyzed for this report; about 600 of these lessons 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.

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\(^1\) Projects conduct “full data collection” in their baseline year, two years later, and at the end of the project.
Teacher Questionnaires
Each project was asked to administer questionnaires to a random sample of teachers for each targeted subject. The median response rate was 83 percent. Teacher questionnaires asked respondents about attitudes, beliefs, preparedness to teach, instructional practices, and so on. A total of 18,555 teacher questionnaires were included in these analyses, including 9,038 from K–8 science teachers; 6,248 K–8 mathematics teachers; 2,617 from 6–12 mathematics teachers; and 652 from 6–12 science 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.

Principal Questionnaires
Projects were also asked to administer questionnaires to the entire population of principals of targeted schools. Respondents were asked their opinions about mathematics and science instruction, factors affecting mathematics/science instruction at their school, and their school’s progress in implementing the LSC reforms. Return rates on the principal questionnaire were generally higher than for the teacher questionnaire, with a median response rate of 94 percent; a total of 3,529 principal questionnaires were used in these analyses.

Teacher Interviews
Evaluators in each of the projects were asked to interview a sample of 10 teachers who had participated in at least 20 hours of LSC professional development activities. A total of 384 interviews from 46 projects were used in this report. Seventy-two percent of the interviews were conducted by telephone, and 28 percent were conducted in person. Evaluators summarized the interview data by completing an interview summary form with both ratings and quotations from the participating teachers. Interview data from each project were weighted to reflect the total number of teachers who had participated in the LSC professional development in that project.

Interviews with LSC Principal Investigators
In addition to the core evaluation activities described above, HRI conducted in-depth interviews with PIs of ending LSC projects in 2000, 2001, and 2002. Interviews conducted in the spring of 2000 with 12 PIs focused on “lessons learned” around professional development providers, professional development activities, and sustaining reform. Interviews with 16 PIs in the spring of 2001, and 19 additional PIs in the spring of 2002, focused on stakeholder and policy support for LSC reforms, and issues related to institutionalization.

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2 The teacher interview protocol underwent major revisions between the 1998–1999 and 1999–2000 data collection years. Thus, only projects that collected teacher interview data as part of their full data collection during the last two years were used in analyses for this report.

3 Eleven of these PIs had been interviewed in 2000 as well; five PIs represented projects that had “officially” ended prior to 2000.
Appendix B
Questionnaire Composites

In the results presented in this report, teachers are categorized by targeted subject (K–8 science, K–8 mathematics, or secondary mathematics; in projects targeting both mathematics and science, or both elementary and secondary mathematics, questionnaire and observation data were collected separately for each “subject”). 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. Unless otherwise noted, teacher leaders are excluded from these analyses. Differences in proportions were tested using Chi-square procedures. Analysis of variance and t-tests were used to test 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.

Analysis and Reporting of Questionnaire Data
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.” Each composite represents an important construct related to one of the key evaluation questions. For example, there is a composite on the quality of LSC professional development, and several on teacher attitudes, preparedness, and classroom practice.

Once the questionnaire items associated with each composite were identified, composite scores were created. The composites are calculated as percentages of total points possible. A composite score is calculated by summing the 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 the raw composite score on these items adds to 24 points, the percentage score is 80 (computed as 24 ÷ 30 × 100). For the teacher questionnaire composites, a project’s mean composite score is computed by averaging the scores of the individual teachers in that project.

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### Table B-1
**Teacher Questionnaire Composite:**
**Attitudes Toward Teaching**

<table>
<thead>
<tr>
<th></th>
<th>Grades K-8</th>
<th>Grades 6–12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sci</td>
<td>Math</td>
</tr>
<tr>
<td>Provide concrete experience before abstract concepts.</td>
<td>7ia</td>
<td>7ia</td>
</tr>
<tr>
<td>Develop students’ conceptual understanding of science/mathematics.</td>
<td>7ib</td>
<td>7ib</td>
</tr>
<tr>
<td>Make connections between science/mathematics and other disciplines.</td>
<td>7id</td>
<td>7ie</td>
</tr>
<tr>
<td>Have students work in cooperative learning groups.</td>
<td>7ie</td>
<td>7if</td>
</tr>
<tr>
<td>Have students participate in appropriate hands-on activities.</td>
<td>7if</td>
<td>7ig</td>
</tr>
<tr>
<td>Engage students in inquiry-oriented activities.</td>
<td>7ig</td>
<td>7ih</td>
</tr>
<tr>
<td>Use computers.</td>
<td>7ih</td>
<td>7ij</td>
</tr>
<tr>
<td>Engage students in applications of science/mathematics in a variety of contexts.</td>
<td>7ij</td>
<td>7ik</td>
</tr>
<tr>
<td>Use portfolios.</td>
<td>7ik</td>
<td>7im</td>
</tr>
<tr>
<td>Use informal questioning to assess student understanding.</td>
<td>7il</td>
<td>7in</td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
<td><strong>10</strong></td>
<td><strong>10</strong></td>
</tr>
<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
<td><strong>.80</strong></td>
<td><strong>.82</strong></td>
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</table>

### Table B-2
**Teacher Questionnaire Composite:**
**Pedagogical Preparedness**

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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Sci</td>
<td>Math</td>
</tr>
<tr>
<td>Provide concrete experience before abstract concepts</td>
<td>7pa</td>
<td>7pa</td>
</tr>
<tr>
<td>Develop students’ conceptual understanding of science/mathematics</td>
<td>7pb</td>
<td>7pb</td>
</tr>
<tr>
<td>Take students’ prior understanding into account when planning curriculum and instruction</td>
<td>7pc</td>
<td>7pc</td>
</tr>
<tr>
<td>Make connections between science/mathematics and other disciplines</td>
<td>7pd</td>
<td>7pe</td>
</tr>
<tr>
<td>Have students work in cooperative learning groups</td>
<td>7pe</td>
<td>7pf</td>
</tr>
<tr>
<td>Have students participate in appropriate hands-on activities</td>
<td>7pf</td>
<td>7pg</td>
</tr>
<tr>
<td>Engage students in inquiry-oriented activities</td>
<td>7pg</td>
<td>7ph</td>
</tr>
<tr>
<td>Engage students in applications of science/mathematics in a variety of contexts</td>
<td>7pi</td>
<td>7pk</td>
</tr>
<tr>
<td>Use performance-based assessment</td>
<td>7pj</td>
<td>7pl</td>
</tr>
<tr>
<td>Use portfolios</td>
<td>7pk</td>
<td>7pm</td>
</tr>
<tr>
<td>Use informal questioning to assess student understanding</td>
<td>7pl</td>
<td>7pn</td>
</tr>
<tr>
<td>Lead a class of students using investigative strategies</td>
<td>11a</td>
<td>12a</td>
</tr>
<tr>
<td>Manage a class of students engaged in hands-on/project-based work</td>
<td>11b</td>
<td>12b</td>
</tr>
<tr>
<td>Help students take responsibility for their own learning</td>
<td>11c</td>
<td>12c</td>
</tr>
<tr>
<td>Recognize and respond to student diversity</td>
<td>11d</td>
<td>12d</td>
</tr>
<tr>
<td>Encourage students’ interest in science/mathematics</td>
<td>11e</td>
<td>12e</td>
</tr>
<tr>
<td>Use strategies that specifically encourage participation of females and minorities in science/mathematics</td>
<td>11f</td>
<td>12f</td>
</tr>
<tr>
<td>Involve parents in the science/mathematics education of their students</td>
<td>11g</td>
<td>12g</td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
<td><strong>18</strong></td>
<td><strong>18</strong></td>
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<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
<td><strong>.94</strong></td>
<td><strong>.94</strong></td>
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<tr>
<td>topic</td>
<td>Grades K–8</td>
<td>Grades 6–12</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>Sci</td>
<td>Math</td>
</tr>
<tr>
<td>The human body</td>
<td>10a</td>
<td></td>
</tr>
<tr>
<td>Ecology</td>
<td>10b</td>
<td></td>
</tr>
<tr>
<td>Rocks and soils</td>
<td>10c</td>
<td></td>
</tr>
<tr>
<td>Astronomy</td>
<td>10d</td>
<td></td>
</tr>
<tr>
<td>Processes of change over time (e.g., evolution)</td>
<td>10e</td>
<td></td>
</tr>
<tr>
<td>Mixtures and solutions</td>
<td>10f</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>10g</td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>10h</td>
<td></td>
</tr>
<tr>
<td>Forces and motion</td>
<td>10i</td>
<td></td>
</tr>
<tr>
<td>Machines</td>
<td>10j</td>
<td></td>
</tr>
<tr>
<td>Engineering and design principles (e.g., structures, models)</td>
<td>10k</td>
<td></td>
</tr>
<tr>
<td>Estimation</td>
<td></td>
<td>12a</td>
</tr>
<tr>
<td>Measurement</td>
<td></td>
<td>12b</td>
</tr>
<tr>
<td>Pre-algebra</td>
<td>10e</td>
<td>12c</td>
</tr>
<tr>
<td>Algebra</td>
<td>10f</td>
<td>12d</td>
</tr>
<tr>
<td>Patterns and relationships</td>
<td></td>
<td>12e</td>
</tr>
<tr>
<td>Geometry and spatial sense</td>
<td>10h</td>
<td>12f</td>
</tr>
<tr>
<td>Functions (including trigonometric functions) and pre-calculus concepts</td>
<td></td>
<td>12g</td>
</tr>
<tr>
<td>Data collection and analysis</td>
<td>10i</td>
<td>12h</td>
</tr>
<tr>
<td>Probability</td>
<td>10j</td>
<td>12i</td>
</tr>
<tr>
<td>Statistics (e.g., hypothesis tests, curve fitting and regression)</td>
<td></td>
<td>12j</td>
</tr>
<tr>
<td>Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)</td>
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<td>12k</td>
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<tr>
<td>Mathematical structures (e.g., vector spaces; groups, rings, fields)</td>
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<td>12l</td>
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<tr>
<td>Calculus</td>
<td></td>
<td>12m</td>
</tr>
<tr>
<td>Technology (calculators, computers) in support of mathematics</td>
<td>10k</td>
<td>12n</td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
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<td>6</td>
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<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
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<td>.87</td>
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### Table B-4
**Teacher Questionnaire Composite:**
**Content Preparedness, Grades 6–12, Science†**

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<tbody>
<tr>
<td>Earth’s features and physical processes</td>
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<td>13a1</td>
<td></td>
<td></td>
<td>13a1</td>
<td>13a1</td>
<td></td>
<td></td>
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<tr>
<td>The solar system and universe</td>
<td>13a2</td>
<td>13a2</td>
<td></td>
<td></td>
<td>13a2</td>
<td>13a2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate and weather</td>
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<td>13a3</td>
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<td></td>
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<td>13a3</td>
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</tr>
<tr>
<td>Structure and function of human systems</td>
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<td></td>
<td></td>
<td></td>
<td>13b1</td>
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<td></td>
<td></td>
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<tr>
<td>Plant biology</td>
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<td></td>
</tr>
<tr>
<td>Animal behavior</td>
<td>13b3</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Interactions of living things/ecology</td>
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<tr>
<td>Genetics and evolution</td>
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<tr>
<td>Structure of matter and chemical bonding</td>
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<tr>
<td>Properties and states of matter</td>
<td></td>
<td>13c2</td>
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<td>Chemical reactions</td>
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<tr>
<td>Energy and chemical change</td>
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<td>13c4</td>
<td>13c4</td>
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<td></td>
</tr>
<tr>
<td>Forces and motion</td>
<td>13d1</td>
<td>13d1</td>
<td>13d1</td>
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<td>13d1</td>
<td>13d1</td>
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<td>Energy</td>
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<td></td>
<td>13d2</td>
<td>13d2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light and sound</td>
<td>13d3</td>
<td>13d3</td>
<td>13d3</td>
<td></td>
<td>13d3</td>
<td>13d3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity and magnetism</td>
<td>13d4</td>
<td>13d4</td>
<td>13d4</td>
<td></td>
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<td>13d4</td>
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<td></td>
</tr>
<tr>
<td>Modern physics (e.g., special relativity)</td>
<td>13d5</td>
<td>13d5</td>
<td>13d5</td>
<td></td>
<td>13d5</td>
<td>13d5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution, acid rain, global warming</td>
<td>13e1</td>
<td></td>
<td></td>
<td></td>
<td>13e1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population, food supply and production</td>
<td></td>
<td>13e2</td>
<td></td>
<td></td>
<td>13e2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formulating hypotheses, drawing conclusions, making generalizations</td>
<td>13f1</td>
<td>13f1</td>
<td>13f1</td>
<td></td>
<td>13f1</td>
<td>13f1</td>
<td>13f1</td>
<td>13f1</td>
</tr>
<tr>
<td>Experimental design</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
<td>13f2</td>
</tr>
<tr>
<td>Describing, graphing, and interpreting data</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
<td>13f3</td>
</tr>
<tr>
<td>Number of Items in Construct</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Reliability (Cronbach’s Alpha)</td>
<td>.90</td>
<td>.81</td>
<td>.84</td>
<td>.91</td>
<td>.90</td>
<td>.93</td>
<td>.93</td>
<td>.89</td>
</tr>
</tbody>
</table>

† This composite was computed for each teacher based upon the subject of his or her first science class of the day. Because the number of teachers in any specific content area may be low within a project, project results are combined into one content composite.

### Table B-5
**Teacher Questionnaire Composite:**
**Investigative Culture**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrange seating to facilitate student discussion</td>
<td>21e</td>
<td>20c</td>
<td>19e</td>
<td>19c</td>
</tr>
<tr>
<td>Use open-ended questions</td>
<td>21f</td>
<td>20d</td>
<td>19f</td>
<td>19d</td>
</tr>
<tr>
<td>Require students to supply evidence to support their claims†</td>
<td>21g</td>
<td>20e</td>
<td>19g</td>
<td>19f</td>
</tr>
<tr>
<td>Require students to explain their reasoning when giving an answer†</td>
<td>21h</td>
<td>20f</td>
<td>19h</td>
<td>19g</td>
</tr>
<tr>
<td>Encourage students to explain concepts to one another†</td>
<td>21i</td>
<td>20g</td>
<td>19i</td>
<td>19h</td>
</tr>
<tr>
<td>Encourage students to communicate mathematically†</td>
<td>22b</td>
<td>21b</td>
<td>20b</td>
<td>20b</td>
</tr>
<tr>
<td>Encourage students to consider alternative explanations†</td>
<td>22c</td>
<td>21c</td>
<td>20c</td>
<td>20e</td>
</tr>
<tr>
<td>Encourage students to explore alternative methods for solutions†</td>
<td>22d</td>
<td>21d</td>
<td>20d</td>
<td>20f</td>
</tr>
<tr>
<td>Participate in discussions with the teacher to further science/mathematical understanding</td>
<td>22e</td>
<td>21e</td>
<td>20e</td>
<td>20f</td>
</tr>
<tr>
<td>Work in cooperative learning groups</td>
<td>22f</td>
<td>21f</td>
<td>20f</td>
<td>20f</td>
</tr>
<tr>
<td>Share ideas or solve problems with each other in small groups</td>
<td>22g</td>
<td>21g</td>
<td>20g</td>
<td>20h</td>
</tr>
<tr>
<td>Number of Items in Construct</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Reliability (Cronbach’s Alpha)</td>
<td>.90</td>
<td>.89</td>
<td>.83</td>
<td>.85</td>
</tr>
</tbody>
</table>

† The mathematics and science versions of this question are considered equivalent, worded appropriately for that discipline.
### Table B-6
**Teacher Questionnaire Composite: Investigative Practices**

<table>
<thead>
<tr>
<th></th>
<th>Grades K–8</th>
<th>Grades 6–12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sci Math</td>
<td>Sci Math</td>
</tr>
<tr>
<td>Make formal presentations to the class</td>
<td>22d 21d 20d 20d</td>
<td></td>
</tr>
<tr>
<td>Engage in hands-on science/mathematical activities</td>
<td>22k 21l 20k 20l</td>
<td></td>
</tr>
<tr>
<td>Design or implement their own investigation</td>
<td>22m 21o 20m 20o</td>
<td></td>
</tr>
<tr>
<td>Work on models or simulations</td>
<td>22o 21p 20o 20p</td>
<td></td>
</tr>
<tr>
<td>Work on extended science/mathematics investigations or projects (a week or more in duration)</td>
<td>22p 21q 20p 20q</td>
<td></td>
</tr>
<tr>
<td>Participate in field work</td>
<td>22q 21r 20q 20r</td>
<td></td>
</tr>
<tr>
<td>Write reflections in a notebook or journal</td>
<td>22s 21u 20s 20u</td>
<td></td>
</tr>
<tr>
<td>Work on portfolios</td>
<td>22w 21y 20x 20y</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
<td>8 8 8 8</td>
<td></td>
</tr>
<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
<td>.83 .85 .79 .84</td>
<td></td>
</tr>
</tbody>
</table>

### Table B-7
**District Policy Ratings Composite: Stakeholder Support for Mathematics/Science Reforms During LSC Funding**

<table>
<thead>
<tr>
<th></th>
<th>Math/Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers targeted by the LSC</td>
<td>TB1a</td>
</tr>
<tr>
<td>Principals</td>
<td>TB1b</td>
</tr>
<tr>
<td>Central office administrators</td>
<td>TB1c</td>
</tr>
<tr>
<td>Parents</td>
<td>TB2a</td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
<td>.63</td>
</tr>
</tbody>
</table>

### Table B-8
**District Policy Ratings Composite: Existence of Systems to Sustain Stakeholder Support for Mathematics/Science Reforms**

<table>
<thead>
<tr>
<th></th>
<th>Math/Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers targeted by the LSC</td>
<td>ThC1</td>
</tr>
<tr>
<td>Principals</td>
<td>ThC2</td>
</tr>
<tr>
<td>Central office administrators</td>
<td>ThC3</td>
</tr>
<tr>
<td>Parents</td>
<td>ThC4</td>
</tr>
<tr>
<td>Mathematics/science-rich institutions</td>
<td>ThC5</td>
</tr>
<tr>
<td>Institutions of higher education</td>
<td>ThC6</td>
</tr>
<tr>
<td>Teacher unions</td>
<td>ThC7</td>
</tr>
<tr>
<td><strong>Number of Items in Construct</strong></td>
<td>7</td>
</tr>
<tr>
<td><strong>Reliability (Cronbach’s Alpha)</strong></td>
<td>.84</td>
</tr>
</tbody>
</table>
### Table B-9

**District Policy Ratings Composite:**

**Existence of Systems to Institutionalize LSC Professional Development**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Math/Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>The district(s) have structure(s) in place for assessing teachers' needs</td>
<td>ThA1</td>
</tr>
<tr>
<td>The district(s) have the capacity to plan and deliver high-quality mathematics/science professional development internally</td>
<td>ThA2a</td>
</tr>
<tr>
<td>The district(s) have the capacity to plan and deliver high-quality mathematics/science professional development through arrangements with an external group (e.g., local university)</td>
<td>ThA2b</td>
</tr>
<tr>
<td>The district(s) tie professional development specifically to the mathematics/science curriculum</td>
<td>ThA3</td>
</tr>
<tr>
<td>The district(s) provide teachers with the opportunity for a coherent professional development plan</td>
<td>ThA4</td>
</tr>
<tr>
<td>The district(s) have incentives in place for teachers to participate in ongoing professional development</td>
<td>ThA5</td>
</tr>
<tr>
<td>The district(s) use staff development days for mathematics/science professional development</td>
<td>ThA6</td>
</tr>
<tr>
<td>The district(s) use district’s federal funds to support mathematics/science professional development: Eisenhower Act</td>
<td>ThA7a</td>
</tr>
<tr>
<td>The district(s) provide teachers with support as they implement in their classrooms what they have learned in professional development</td>
<td>ThA8</td>
</tr>
<tr>
<td>The district(s) have systems in place for orienting new teachers to mathematics/science education</td>
<td>ThA9</td>
</tr>
</tbody>
</table>

**Number of Items in Construct:** 10

**Reliability (Cronbach’s Alpha):** .92

---

### Table B-10

**District Policy Ratings Composite:**

**Alignment of District Policies with the LSC Vision**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Math/Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics/science curriculum framework/scope and sequence</td>
<td>TA1</td>
</tr>
<tr>
<td>Selection of instructional materials</td>
<td>TA2</td>
</tr>
<tr>
<td>Systems for purchasing and managing materials and supplies</td>
<td>TA3</td>
</tr>
<tr>
<td>District-wide student assessment</td>
<td>TA5</td>
</tr>
<tr>
<td>Evaluation of teacher performance</td>
<td>TA6</td>
</tr>
<tr>
<td>Consistency of LSC mathematics/science reforms with other district reforms</td>
<td>TA7</td>
</tr>
<tr>
<td>Organizational structures/policies within schools (e.g., time for preparation and planning; importance placed on mathematics/science)</td>
<td>TA8</td>
</tr>
</tbody>
</table>

**Number of Items in Construct:** 7

**Reliability (Cronbach’s Alpha):** .79

---

### Table B-11

**District Policy Ratings Composite:**

**Existence of Systems to Maintain Alignment of District Policies with the LSC Vision**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Math/Sci</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics/science curriculum framework/scope and sequence</td>
<td>ThB1</td>
</tr>
<tr>
<td>Selection of instructional materials</td>
<td>ThB2</td>
</tr>
<tr>
<td>Systems for purchasing and managing materials and supplies</td>
<td>ThB3</td>
</tr>
<tr>
<td>District-wide student assessment</td>
<td>ThB4</td>
</tr>
<tr>
<td>Recruiting/hiring new teachers</td>
<td>ThB5</td>
</tr>
<tr>
<td>Evaluation of teacher performance</td>
<td>ThB6</td>
</tr>
<tr>
<td>Organizational structures/policies within schools (e.g., time for preparation and planning; importance placed on mathematics/science)</td>
<td>ThB7</td>
</tr>
</tbody>
</table>

**Number of Items in Construct:** 7

**Reliability (Cronbach’s Alpha):** .85
Appendix C
Impacts of the LSC

Table C-1
Summary of the Impact of LSC Professional Development on Teacher Perceptions of Their Preparedness and of Their Teaching as Measured by Teacher Questionnaire Composites

<table>
<thead>
<tr>
<th></th>
<th>Grades K–8</th>
<th>Grades 6–12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Effect</td>
</tr>
<tr>
<td></td>
<td>of SDs†</td>
<td>Size§</td>
</tr>
<tr>
<td>Attitudes Toward Teaching</td>
<td>.28</td>
<td>+</td>
</tr>
<tr>
<td>Pedagogical Preparedness</td>
<td>.70</td>
<td>++</td>
</tr>
<tr>
<td>Content Preparedness</td>
<td>.47</td>
<td>+</td>
</tr>
<tr>
<td>Investigative Culture</td>
<td>.56</td>
<td>++</td>
</tr>
<tr>
<td>Investigative Practices</td>
<td>.63</td>
<td>++</td>
</tr>
</tbody>
</table>

† Number of standard deviations between untreated teachers and teachers with 80 or more hours LSC professional development.
‡ Number of standard deviations between untreated teachers and teachers with 40 or more hours LSC professional development
§ NS = Not significant; p < 0.05; a “+” indicates a small positive effect; a “++” indicates a medium positive effect.

Table C-2
Summary of the District Policy Rating Composites

<table>
<thead>
<tr>
<th></th>
<th>Baseline Year vs. Final Year</th>
<th>Final Year vs. Final Year, Likely to Exist After the LSC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of SDs</td>
<td>Effect Size§</td>
</tr>
<tr>
<td>Stakeholder Support for Mathematics/Science Reforms During LSC Funding</td>
<td>0.80</td>
<td>+++</td>
</tr>
<tr>
<td>Existence of Systems to Sustain Stakeholder Support for Mathematics/Science Reforms</td>
<td>1.46</td>
<td>+++</td>
</tr>
<tr>
<td>Existence of Systems to Institutionalize LSC Professional Development</td>
<td>2.53</td>
<td>+++</td>
</tr>
<tr>
<td>Alignment of District Policies with the LSC Vision</td>
<td>0.68</td>
<td>++</td>
</tr>
<tr>
<td>Existence of Systems to Maintain Alignment of District Policies with the LSC Vision</td>
<td>1.59</td>
<td>+++</td>
</tr>
</tbody>
</table>

NS = Not significant; p < 0.05; a “+” indicates a small positive effect; a “++” indicates a medium positive effect; a “+++” indicates a large positive effect; a “-” indicates a small negative effect; a “- -” indicates a medium negative effect.
Appendix D
Use of LSC-Designated Instructional Materials

Table D-1
Use of LSC-Designated Instructional Materials as the Basis of Mathematics/Science Lessons, by Participation in LSC Professional Development

<table>
<thead>
<tr>
<th>Hours</th>
<th>Never (a few times a year)</th>
<th>Rarely (once or twice a month)</th>
<th>Sometimes (once or twice a week)</th>
<th>Often (once or twice a week)</th>
<th>All or almost all lessons</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Hours</td>
<td>50</td>
<td>14</td>
<td>14</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>1–19 Hours</td>
<td>14</td>
<td>17</td>
<td>23</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>20–39 Hours</td>
<td>7</td>
<td>14</td>
<td>19</td>
<td>26</td>
<td>34</td>
</tr>
<tr>
<td>40–79 Hours</td>
<td>5</td>
<td>9</td>
<td>20</td>
<td>27</td>
<td>39</td>
</tr>
<tr>
<td>80 or more Hours</td>
<td>4</td>
<td>7</td>
<td>15</td>
<td>27</td>
<td>47</td>
</tr>
</tbody>
</table>