

Teacher Leadership as a Strategy for Instructional Improvement: The Case of the Merck Institute for Science Education

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Biography

Kate Riordan is a Research Specialist with the Consortium for Policy Research in Education (CPRE) at the University of Pennsylvania. She joined CPRE in 2001 after completing her doctoral degree in educational policy studies at Pennsylvania State University. Her master's degree in Human Development and Family Studies is also from Pennsylvania State University. She is involved in two evaluation studies at CPRE — the evaluations of the Merck Institute for Science Education, and the America's Choice school design. Her research interests include school reform and other influences on children's school readiness and achievement throughout school.

About MISE

In 1993, Merck & Co., Inc. began an endeavor to make a significant and visible commitment to improving science education by creating the Merck Institute for Science Education (MISE) and supported the new venture with a 10-year, \$20-million financial commitment. From its inception, MISE had two goals: to raise the interest, participation, and performance of public school students in science, and to demonstrate to other businesses that direct, focused involvement would hasten the improvement of science teaching and learning in the public schools. MISE initiated its work by forming partnerships with four public school districts — Linden, Rahway, and Readington Township in New Jersey, and North Penn in Pennsylvania — where Merck had major facilities. To learn more about MISE, visit www.mise.org.

CPRE's Evaluation of MISE

CPRE, based at the University of Pennsylvania, was contracted by MISE in 1993 to document the implementation of the initiative and assess its impact on districts, schools, classrooms, and students. Throughout the evaluation, CPRE conducted interviews with teachers, instructional leaders, and district personnel; surveyed teachers; developed case studies of schools; and examined student achievement data in order to provide feedback on the progress of the MISE Partnership.

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Glossary of Terms

Merck Institute for Science Education (MISE) Partnership — Created in 1993 by Merck & Co., Inc., MISE began a 10-year commitment to the goal of raising student interest, participation, and performance in science. MISE formed partnerships with school districts in Linden, Rahway, and Readington Township in New Jersey, and North Penn in Pennsylvania.

Guided Inquiry/Inquiry-based Instruction — A method of instruction that parallels the scientific method. Teachers inspire students to become interested in the subject matter and form their own questions and hypotheses about certain ideas. Teachers provide resources or facts that will help students further investigate their questions. Teachers act as guides while students form and investigate questions.

Leader Teacher Institute (LTI) — Launched in 1995 to provide intensive professional development to a select group of teachers from each partner school over a three-year period. These teachers would then become the Leader Teachers within their schools.

Leader Teacher — Selected teachers who attended LTIs and worked with new teachers by orienting them to the new module-based science curriculum and provided instructional guidance and support.

Peer Teacher Workshops (PTWs) — Launched by MISE in 1996, PTWs provided professional development opportunities open to all K-8 teachers in an effort to engage more teachers in science reform. PTWs were open for voluntary enrollment and each was led by a team consisting of a combination of Leader Teachers, content specialists, instructional specialists, and classroom teachers.

Instructional Teams — Teams consisting of those who led the LTIs or PTWs. MISE held workshops for the instructional teams so they could plan their sessions, gather materials, and learn strategies for teaching adult learners. Instructional teams included MISE staff, outside experts, Leader Teachers, and other district staff members.

Principals' Institutes — MISE offers Principals' Institutes to make sure that principals are remaining informed about, and support, inquiry-based instruction and other aspects of the reform process.

Introduction

Since 1993, the Merck Institute for Science Education (MISE) has been working with four school districts — Linden, Rahway, and Readington Township in New Jersey and North Penn in Pennsylvania — to improve teaching and learning in science. MISE has taken a systemic approach to its work with these four district partners. Guided by a vision of high-quality science instruction in which guided inquiry is an integral and regular part of the classroom experience of all students, MISE and the four districts formed a unified Partnership that developed a strong professional development strategy to support teachers' use of inquiry in science. The strategy includes the development of professional cultures in schools and districts that will support the desired changes in practice. One of the major strategies has been to develop teacher leaders in the schools who were willing, and able, to serve as champions of the instructional reforms and provide support to other teachers who are implementing them. In this report, we describe MISE's approach to the development of teacher leadership and examine the effects that this strategy has had on its partner districts and schools.

MISE's Vision of Science Teaching

Advocates of inquiry-centered teaching argue that science teaching and learning should parallel the methods scientists use to understand the natural world. Student investigations of natural phenomena lie at the heart of this approach, and the purpose of these investigations is to develop the skills central to scientific inquiry. The key assumption of MISE is that engaging students in science will develop greater interest in, and deeper understanding of, science than is possible through conventional instructional approaches.

This view of high-quality science education holds that the most important instructional experiences are investigations that challenge students to observe, question, hypothesize, test, and defend their ideas about science and the world around them. To teach in this manner, teachers must have a firm grasp of the subject matter so they can encourage students to both ask critical questions and seek meaningful answers. Teachers are expected to create active classroom environments that encourage inquiry and support students as they test hypotheses.

MISE's Theory of Action

MISE staff recognized from the beginning that inquiry-centered instruction would require considerable knowledge of science and sophisticated pedagogical skill to guide and manage classrooms; they also recognized that many public school teachers currently do not possess such knowledge or skill. To achieve their goal, MISE staff developed a systemic strategy that placed professional development at the heart of the work. Stated in broad terms, their strategy consisted of the following components:

- Developing a new leadership team in each district that included principals and teachers who shared a commitment to improving science teaching;
- Developing a shared vision of reformed practice grounded in inquiry and consistent with state and national standards;
- Supporting the efforts of district teams to make the improvement of science teaching a priority, and to engage in serious planning to address it;
- Helping districts to develop new curriculum frameworks for science and to adopt new instructional materials compatible with inquiry-centered instruction;

- Helping districts align other policies and procedures (assessment, teacher evaluation, materials management, and most importantly professional development) with the new frameworks;
 - Developing district capacity to plan and deliver professional development and support implementation of the new curriculum;
 - Developing professional cultures in the districts and schools that would promote continuous improvement of science teaching and development of teacher expertise; and
 - Promoting supportive state policies.
3. To what degree have the strategies been successful in developing professional learning communities in science in which individuals with content expertise are enabled as leaders?
 4. What role have principals played in this effort?
 5. To what degree has MISE succeeded in changing the leadership culture in the central offices of the districts?
 6. How effective have these strategies been in altering district capacity to sustain the work and taking it to scale?
 7. What can we learn from MISE's experience about the conditions under which distributed leadership takes hold and flourishes?

A critical part of this strategy has been the development of teacher leaders in the schools as well as others in the central offices who understood inquiry-centered instruction and could help others implement it. In particular, MISE has focused on teacher leaders, recognizing that their expertise would provide the districts with the capacity for improvement, and that their roles in the schools and in the central offices would be critical to sustaining the work, grounding it in the realities of practice, and legitimating it for other teachers.

In this report, we examine MISE's effectiveness in developing instructional leadership in science in its partner districts and address the following questions:

1. What strategies has MISE employed to develop teacher leadership in science? How have these strategies changed over time?
2. How effective have these strategies been in creating new roles and increased influence for teachers? How have teachers' roles changed? What obstacles or problems have been encountered?

To answer these questions, we examine data from three sources: eight evaluative reports by the Consortium for Policy Research in Education (CPRE) on the work of MISE; a qualitative database that includes interviews with principals, Leader Teachers, and science supervisors conducted over the past nine years; and quantitative data from principal and teacher surveys collected between 1996-2001. These data sources all contribute to the story of MISE's efforts to establish distributed leadership in the 34 partner schools.

Theoretical Framework: Instructional and Distributed Leadership

The implementation of instructional reforms requires leadership and support in the schools. Most of the research literature assumes that this leadership must come from school principals. In study after study, researchers examining the factors affecting the implementation

of reforms have taken this position (Elmore, 2000; Newmann, 1996; Spillane, Halverson, & Diamond, 2001). The research literature suggests that principals provide their staffs with vision and focus, creating coherence within their schools. They support the efforts of teachers to improve their practice, building strong professional communities that focus on results and promote collaboration. They provide assistance to teachers who need it. They carefully allocate resources, including time, to support the instructional priorities of their schools. They buffer their staff from countless distractions. In sum, principals play a critical role in improving instruction.

Elmore (2000) argues that many school leaders are not adequately prepared to carry out the tasks of improving instruction. Classroom instruction can be improved, he contends, only if school leadership is substantially redefined and changed. The early organization of public schools was characterized by centralized local bureaucracies, governance by elected boards, teachers who were isolated from one another, and a primarily male supervisory body who handled administrative, rather than pedagogical, concerns and development. In many ways, these elements have remained in place for over a century.

Elmore (2000) discusses two implications of this organizational legacy. The first implication is weak professional development due to the perception that teaching requires no specific expertise, but depends on the traits of the individual teacher. In short, teaching is viewed as a craft, not as a profession. The second implication is the disconnect between classroom practice and school administration. The technical or pedagogical core is the responsibility of individual teachers, rather than the organization in which practice takes place. School administrators are responsible for the management of the process surrounding instruction, but play a limited role in

instruction. Administrators traditionally have taken charge of finances and management, and teachers traditionally have been given responsibility for instruction. School administrators are expected to maintain public confidence that operations will be smooth and effective, but traditionally have not taken responsibility for quality of instruction.

Traditional models of school leadership are based on this dichotomy — teachers are in charge of the instruction and technical core of the classroom and principals act as managers, image keepers, and buffers from the public. Principals often are overburdened by their managerial roles and are not able to focus on building instructional capacity, modeling, and student achievement, even if they desire to. Studies have shown that school leaders, especially within low-performing schools, are typically ineffective in providing support and mentoring to improve instruction, and providing direction and resources for teacher learning and professional development within and outside of school. In other words, the one role that is frequently not attended to is the instructional leader. This pattern continues despite much research, dating back to the 1970s, which identifies the importance of this role (Stricherz, 2001).

The realization that improving instruction requires shifts in the behavior of school leaders has spurred new theories of school leadership and attempts at restructuring school organization. Contemporary conceptions of school leadership have moved away from the notion of a single leader in a traditionally hierarchical school organization to the more complex idea of distributed leadership shared by multiple individuals at different levels of the organization (Spillane, 1999). The model of distributed leadership “challenges the conventional roles of policy and administrative leaders in buffering [that] practice from outside interference. It posits instead a model in which instructional practice is a collective

good — a common concern for the whole institution — as well as a private and individual concern” (Elmore, 2000, p. 24). It is this theory of distributed leadership that underlies the strategies of MISE.

The theory of distributed leadership assumes that leadership is practiced both formally and informally in schools in a variety of ways and by a host of individuals at different levels, and portrays how leadership functions are actually carried out in schools focused on the improvement of teaching and learning. A distributed leadership model requires principals to be more involved in instruction and teachers to be more involved as leaders. Distributing leadership within the school empowers both teachers and administrators to be part of “a major change in form, nature, and function of some phenomenon” in the school (Bennis & Nanus, 1985 as cited in Spillane, Halverson, & Diamond, 2001).

In order for a distributed form of leadership to develop, a stronger relationship must be formed between leadership and instruction. This is a transformational view of leadership (Spillane, Halverson, & Diamond, 2001) — that a leader has the ability to manage resources, empower others, and transform instructional practice. Under these conditions, teachers and principals become reciprocal leaders engaged collectively in leadership (Spillane, Halverson, & Diamond, 2001). This is especially important in science because few principals have deep backgrounds in the subject.

Spillane, Hallett, and Diamond (2000) discuss the ways in which instructional leadership roles are defined and allocated. These roles are determined by the recognition of, and emphasis on, various forms of capital — human, social, cultural, and economic — possessed by individuals in the school. Leadership based on human capital is rooted in

valued knowledge, background, skills, and expertise. Leadership gained through social capital is based on valued networks and trusting relationships. Cultural capital refers to knowledge, beliefs, and behaviors that are valued by the organization, and suggests cultural competence. Economic capital, such as funding for teachers to attend or lead professional development workshops and provision of materials, also contributes to leadership development. Principals usually possess the most capital as they control valued material resources and possess broad knowledge. Both teachers and principals may possess these types of capital, but interestingly, Spillane, Hallett, and Diamond (2000) found that teachers more often viewed colleagues as sources of social and human capital and were more likely to view principals as leaders in terms of cultural and economic capital. Once it is recognized that the various forms of capital are distributed, it is easy to see how leadership can be strengthened by relying on multiple sources of capital, rather than only on the principal. In fact, this is what happens in the most successful schools.

Distributed leadership rests on this notion that various forms of capital are important and provide a basis for leadership. It offers a more complex view of the relationship between leadership and instruction. In this perspective, instructional improvement is dependent on both the leadership of principals and teachers. This view of leadership seems consistent with the approach that MISE has taken to develop teacher leadership. Therefore, we will use this framework to examine MISE’s work and to gain insight into how the practice of leadership in the partner schools changed over time. In theory, this distributed leadership model is appealing, and the MISE experience allows us to examine whether it is possible to intentionally create it to support changes in practice in one area of curriculum.

Distributed Leadership as a Reform Strategy

From the beginning of their work with the four districts, MISE staff recognized that expertise in science and the teaching of science were needed to design and implement the policies, programs, and procedures required to support the improvement of science teaching. They also recognized that few central office administrators and school administrators possessed this expertise. Therefore, from the beginning of the Partnership, MISE staff felt that accomplished teachers who did possess the requisite expertise had to be part of the planning and development process in the districts. Thus, from its inception, MISE's strategy incorporated the idea of distributed leadership.

Therefore, MISE's reform strategy challenged the traditional school organization by preparing teachers to assume instructional leadership roles in their schools and by pushing the idea of distributed leadership in the partner schools and districts. To assess how well this strategy worked and answer the questions posed in the introduction of this report, we will examine the following four aspects of the work done by MISE and the partner districts in some detail:

1. The development of teacher leadership through preparation of teams of "Leader Teachers" for each school;
2. The development of teacher leadership through involvement of all teachers of science in professional development;
3. The development of teacher leadership through the involvement of teachers in district planning, development and delivery of district professional development, and the development of curriculum frameworks and assessment tools; and

4. The preparation of principals to support the reforms in their schools.

We will examine how MISE's strategies have affected leadership in the schools and districts, particularly the roles that teachers play.

The Development of Teacher Leaders in the Schools

In the early 1990s, science was not a high priority for most K-8 educators in New Jersey and Pennsylvania. There was little state leadership for reforming science education in either state, and there were no statewide movements to reform science education in the elementary and middle grades. Neither state had adopted science content standards. Further, the two states' assessment systems focused only on basic skills in reading, writing, and mathematics. At the district level, science was considered a core subject, but was given considerably lower priority than reading, writing, or mathematics. Three of the four partner districts had no science supervisors. Many teachers within the districts lacked sophisticated science knowledge and sufficient skill to guide inquiry-based learning.

MISE used several strategies to develop, strengthen, and sustain leadership in the districts. Its strategies were based on the principle that high-quality science instruction is inquiry-based and requires teachers to possess ample content knowledge and pedagogical skills.

During its first year, MISE staff helped local educators envision a new approach to science education by sponsoring teams from each district to attend an institute offered by the National Science Resources Center (NSRC) where they were exposed to the concept of

inquiry teaching and new curriculum materials. At the NSRC institute, the teams began work on a strategic plan for the reform of science teaching. MISE then assisted the partner districts with the selection and purchase of new instructional materials for elementary science and supported some related local professional development activities. MISE personnel also created a resource center enabling staff in the partner districts to review and test new instructional materials without purchasing them.

Although the provision of curriculum materials and resources was a positive first step, it quickly became clear to MISE staff that they needed to provide more direct support for teachers to produce the desired changes in their practice. One of the major challenges to be addressed was the weak content knowledge of many K-8 science teachers. MISE determined that before student achievement in science could increase, teachers needed to be better equipped with instructional techniques, content knowledge, and curriculum materials.

A strategy soon emerged to meet these needs, the core of which was the design of the Leader Teacher Institute (LTI). MISE and its advisory committee realized that the changes in teaching and learning they were seeking required staff development that was focused, continuous, and enduring. Based on the premise that all students should experience standards-based science instruction, the LTI was designed to prepare teams of Leader Teachers to be more effective science teachers and to be instructional change agents within their schools and districts by serving as role models, advocates, coaches, and instructors.

The LTI, which began in the summer of 1995, was a voluntary, three-year professional development experience for a set of three or four teachers from each elementary and middle school in the four

partner districts. Summer and academic-year sessions focused on fortifying teachers' content knowledge and skills, developing their leadership skills to support reform, and broadening their understanding and competence in reforming science education in their schools. Personal release days during the academic year permitted participating Leader Teachers to design their own follow-up professional development experiences. In addition to the opportunities for learning and influencing policies in their schools and districts, other incentives for participation included academic credit offered by local colleges and universities, and stipends provided through a National Science Foundation (NSF) grant and MISE. Principals and other district administrators were invited to attend LTI sessions and to participate in planning school-level reform activities with their Leader Teachers.

The LTI had three core components: a three-week summer institute held each year for three years, three full-day and three half-day sessions held during the academic year, and four days of release time for professional development activities designed by and for each participant. As part of their summer experience, approximately 140 teachers participated in intensive inquiry-centered strands in life, earth, or physical science. Leader Teachers attended one of these strands each summer and completed all the strands over the three years. In the summer of 1997, time was also allocated for pedagogy, assessment, equity issues, the integration of science and literature, communication skills, leadership, and applications of technology.

An instructional team composed of a science content specialist and three practitioners led each of the three strands. Instructional teams included MISE staff, outside experts, Leader Teachers, and other district staff members. The number of Leader Teachers serving on these

instructional teams increased from 1996 to 1997. Each year, the instructional teams worked together for five to seven months before the summer sessions began to design or revise curriculum and instruction, and met daily during the summer sessions to refine their program. Leader Teachers who served on the instructional teams reported that their confidence, knowledge, and skills dramatically increased as a result. The instructional team experience encouraged individual Leader Teachers to assume greater leadership roles in their districts — serving as in-service presenters and panelists at national conferences, and making presentations at state conferences. By 1997, teacher leadership was beginning to become self-sustaining. However, MISE still needed to support Leader Teachers and define their roles, which did not always happen.

In the third and final summer, the instructional teams emphasized the connections across the three strands, helping Leader Teachers conceptualize the central ideas spanning the life science, earth science, and physical science content strands. In addition, the Leader Teachers were asked to analyze the design of the strands and the instructional strategies used by the instructional teams. Increased emphasis was placed on building the capacity of Leader Teachers to develop equitable classrooms and to communicate with their peers.

The concept of the LTI is consistent with the theory of distributed leadership. As discussed earlier, conceptions of school leadership are moving away from the notion of a single leader in a traditionally hierarchical school organization to the more complex idea of distributed leadership shared by multiple individuals at different levels of the organization (Spillane, 1999). MISE envisioned that the Leader Teachers would increase their content knowledge, develop the “habits of mind” of science learners, and provide

leadership within their schools. They were expected to share what they were learning with their colleagues and to help build professional cultures in the schools that supported implementation of inquiry, reflection, and collaboration. Through the LTI, MISE provided Leader Teachers with cultural capital that they could pass on to peers and new teachers.

The Development of Human, Social, and Cultural Capital

An important step in developing distributed leadership is providing teachers with capital that defines their roles and provides them with needed resources. The critical capital that provides a basis for leadership is intangible, consisting of knowledge and skills (human capital), understanding of new roles and social networks for support and sharing (social capital), and the adoption of specific norms, values, and behaviors (cultural capital). As we shall see, MISE provided the Leader Teachers with all three forms of capital, but was more successful in developing the human capital of the Leader Teachers than in providing them with the social and cultural capital needed to assume leadership roles in their schools.

There also was some tangible capital — in the form of money, instructional materials, lesson plans, and laptop computers. The fact that MISE could pay Leader Teachers to go to training and pay instructional team members for their time was a significant factor in recruiting people. MISE also paid the teachers to attend Peer Teacher Workshops (PTWs), professional development that began in 1996 and will be discussed later. Having laptop computers allowed Leader Teachers to access information from the Internet, communicate with peers, and gain expertise in using technology. In the first year of the LTI, MISE obtained e-mail accounts for each Leader Teacher and

sponsored an electronic listserv. In particular, the listserv was an important way of building and supporting a sense of professional community among Leader Teachers, enabling them to communicate and share ideas about teaching, curriculum, and assessment, and to explore the wealth of information available on the Internet. The listserv and e-mail were also an effective means of disseminating information across the Partnership, allowing teachers to increase their comfort level, and have meaningful experiences, with technology.

The Impact of the Leader Teachers in their Schools

CPRE evaluators collected substantial evidence that Leader Teachers took their new responsibilities seriously and attempted to provide leadership in their schools and districts. In a follow-up survey of Leader Teachers in 1995 (three months after the first LTI), Leader Teachers indicated that they perceived their roles in the following order: sharing and collaborating with peers, practicing what was learned in the LTI, serving as a catalyst for change, continuing to learn and improve, and supporting other teachers. Based on interviews with Leader Teachers in 1997, CPRE learned that the teachers assumed roles that could be categorized into five areas: serving as on-request resources, providing outreach to individual teachers, providing individual outreach school-wide, providing team outreach school-wide, and serving district-wide needs. We discuss each of these areas below.

- **On-request resources.** Virtually all the Leader Teachers saw themselves as providing on-request resources for other teachers in their schools. They tried to be available to assist teachers in their own schools with any science-related issues that arose. For most Leader Teachers, this was just one dimension of their role, but some

Leader Teachers did not feel comfortable going beyond this role. These teachers felt this was the extent of their capability and they were uncomfortable with the expectation that they should take on other leadership roles. These Leader Teachers explained that they joined the LTI to improve their classroom teaching, and the leadership expectation emerged only later in the experience.

- **Outreach to individual teachers.** Many of the Leader Teachers reported that they worked on an individual basis with other teachers in their schools. Most Leader Teachers referred to this work as coaching, in which they worked with another teacher over time to help them teach one of the science modules, to design or modify assessment tasks that were more authentic or more closely aligned with the unit, or to develop curriculum. These Leader Teachers frequently mentioned that the other teachers were grade-level partners, or, in a few cases, student teachers.
- **Individual outreach school-wide.** Leader Teachers reported organizing or implementing activities for groups of teachers or for the whole school. One Leader Teacher commented in a 1997 interview that “[her] role is building strength at my grade level in a cooperative vein.” Leader Teachers from several schools reported collaborating on curriculum with groups of teachers who had participated in the PTWs. A special education Leader Teacher described how she facilitated a workshop on inclusion and inquiry-centered science for her school’s staff. Another Leader Teacher explained how she assisted in revamping the district’s science curriculum. Several Leader Teachers mentioned how they coached groups of teachers at their grade level or provided ongoing support to graduates of the PTWs.

- **Group outreach school-wide.** Leader Teachers in about half of the Partnership schools worked as teams to provide activities for their school or community. These activities varied depending on the school context and needs. In several cases, the collaboration involved the design and implementation of science fairs or science nights for students, families, and interested others. Leader Teachers at another school organized science career days for students. In another case, Leader Teachers worked together to develop a school-wide structure for developing and sharing lesson plans. In a few cases, Leader Teachers developed rich themes which they used to model reform strategies for other teachers. These strategies included eliciting student questions, using assessment to gauge prior knowledge, inquiry-centered activities, and linking curricula to standards. Group outreach was very structured in some schools and more informal in others. One Leader Teacher said, "In the whole school, there has been tremendous growth. As a group of Leader Teachers, we did it [provided support] as necessary. We all did different things to help within the building. It's very informal, but we all get around." This is evidence of successful distributed leadership; the effects of the LTI trickled down to other teachers.
- **District-wide influence.** A number of Leader Teachers were involved in reform at the district level. This role, however, was mentioned less frequently in interviews with Leader Teachers than the other roles described above. Most of the district-wide influence was in the form of involvement with professional development. Several Leader Teachers described how they led district in-service days. Leader Teachers also assumed an increasingly prominent

role in planning and leading PTWs in their districts. Leader Teachers in each district served on science curriculum and frameworks committees. Leader Teachers were an integral part of their districts' representation on the MISE advisory committee which brings together leadership groups from the four partner districts to discuss strategic issues and formulate policies and other reforms. A few Leader Teachers mentioned that they represented their districts by speaking at state science conferences.

Principal Support for Leader Teachers

Research has repeatedly shown that principals play key roles in instructional change in their schools. Their level of involvement often dictates whether attempts to change instruction succeed or not. Principals reported various ways in which they supported the work of the Partnership and Leader Teachers in their schools. Several principals met regularly with their Leader Teachers, as one principal described, "to foster the Merck initiatives throughout the school." An elementary principal said, "The Leader Teachers have had a presence in the building. They are role models for others to emulate." One principal organized the school schedule so that Leader Teachers could go to other teachers' classrooms to support their science instruction. Several principals from different districts mentioned that schools and districts needed to better define the roles of Leader Teachers. This issue of role definition will be examined later in a discussion of the limitations of the Leader Teacher strategy.

The importance of principals and the variation in their support was revealed in interviews conducted with Leader Teachers in 1996. Some Leader Teachers mentioned principals and school structures that were highly supportive of their

efforts. Other Leader Teachers described situations in which school leadership seemed to be in constant transition and, consequently, supporting Leader Teachers was not a high priority. Still other Leader Teachers said their school administrators seemed to have no interest in using them in any capacity beyond their own classrooms.

Leader Teachers from several schools across the Partnership described receiving outstanding support from their principals. “Our principal is 150% behind the Merck initiative,” said one Leader Teacher. A principal in another school held monthly meetings with her Leader Teachers and involved them in school decision-making about science. A Leader Teacher from this school commented, “She treats us as leaders. She looks for needs in the building and uses us as leaders in the school.” Another Leader Teacher described how her principal “meets with us to discuss science issues before they are brought to the rest of the faculty. We are appreciative that she asks for our input first. She respects us for our efforts with Merck.”

Other Leader Teachers described indifferent administrative support in their schools. One Leader Teacher said, “It is passive support. They are supportive but not involved.” Another Leader Teacher felt that the continual change in the administrative staff made stable support of high-quality instruction impossible. “It is not intentional,” she said, “But things are so vague, you just don’t know from one day to the next, and these things play against the initiatives such as Merck.” In several other cases, Leader Teachers felt there was no place for teacher leadership in their schools, and that authority rested with the administrative staff, not the faculty.

Later, MISE held leadership seminars to help school administrators learn about inquiry-centered instruction, share strategies for supporting reform and teacher

leadership, and openly discuss issues they face in changing science teaching practices. However, at the time that the Leader Teachers were being asked to assume new roles, principals had not received this training.

In 1998, CPRE evaluators did an analysis of school-based factors that influenced inquiry-based instruction. Principal support was the most powerful influence among the school-level predictors of reform-based teaching practice. In the science teaching model, principal support was statistically highly associated with reform-based teaching practice. Teachers in schools with supportive principals were far more likely to use inquiry-centered practices than teachers in schools where the school leader was not supportive.

The Impact of the LTI: Mixed Results

Did participation in the LTI training alter the classroom practice of the Leader Teachers?

In order to assess whether participation in the LTI was related to instructional change, CPRE evaluators observed and rated teachers using an authentic pedagogy framework. Each lesson was examined for the presence of the following aspects of instructional quality:

- Higher-order thinking skills,
- Substantive conversation,
- Deep knowledge, and
- Connections to the world.

Science activities in the Leader Teachers’ classrooms looked very different to observers than those observed in the classrooms of teachers who had not participated in any Partnership-sponsored professional development. In the classes of Leader Teachers, there were more visible examples of higher-order thinking, more evidence of substantive

conversation between students and teachers and among students, and more evident attention to the complex ideas underlying deep understanding. In general, after three years, the practice of Leader Teachers was more inquiry-centered.

Did the Leader Teacher initiative have positive effects on instructional culture, practice, and student learning?

Part of CPRE's evaluation plan of MISE for 1998-1999 called for a more in-depth look at the work of Leader Teachers. Although their formal professional development had been completed, Leader Teachers were expected to continue to carry out their work in their classrooms, schools, and districts. CPRE and MISE agreed that it would be valuable to survey Leader Teachers about their leadership activities, their comfort in their roles, and the amount of support they were receiving. In the spring of 1999, the population of Leader Teachers still in the districts (122 teachers) was surveyed with an instrument developed by CPRE with collaboration from MISE staff. The survey focused on Leader Teachers' continued commitment to the work of standards-based science reform, how they were conceiving of and practicing leadership in their schools, and their perceptions of school and district supportiveness.

Several themes were apparent in the survey data as well as in interview data. Although teachers reported that their roles were often ambiguous, it was clear that distributed leadership had begun to evolve in the schools. Leader Teachers reported that the LTI had a strong impact on their own subject matter and pedagogical knowledge, and they accepted and internalized the responsibilities they were prepared to assume. In an open-ended question on the survey, Leader Teachers were asked how they promoted standards-based science during the 1998-

1999 school year. The most frequent responses were: curriculum committee participation, presenting at department meetings and in-service days, building planning team membership, serving as a mentor teacher, facilitating PTWs, participating in professional development committees, and coaching of colleagues.

While designing the Leader Teacher survey, CPRE evaluators had a series of conversations with MISE staff to identify both the key elements of the leadership work Leader Teachers were expected to carry out and the sequence in which those elements would likely occur. Based on these discussions, CPRE constructed a hypothesis that Leader Teachers would work through four phases with their colleagues. First, they would assess the needs of other teachers in their school. Second, they would attempt to increase the awareness of other teachers in the importance of standards-based science. Third, they would identify steps to change the practices of other teachers in their school. Finally, they would actively work with other teachers in their school to change their teaching practice.

The Leader Teacher survey explored whether or not the hypothesized sequence of the work reflected their actual experience. Less than half of the Leader Teachers reported feeling fairly well or very well prepared to assess the needs of other teachers in their school. Leader Teachers felt the most adequately prepared to increase the awareness of others about the importance of standards-based science (77% reported being at least fairly well prepared) and to actively work with other teachers in their schools to change practice (72% reported being fairly well prepared). Yet, only about half of the Leader Teachers reported that they were at least sometimes identifying steps to change the practices of other teachers in their school and were actively working with other teachers in their school to change their teaching practices.

Nevertheless, most Leader Teachers were committed to their work as Leader Teachers. In 1999, over 80% said that they felt committed to continuing their leadership work in the schools, even though the formal LTI ended in 1997. Most of them (95%) reported feeling comfortable advocating standards-based science to their colleagues. They tried to carry out their work as advocates and mentors in spite of the fact that they did not always feel fully prepared to do it or supported by their principals. Conventional wisdom suggests that individuals need to feel prepared before they do something — whether it is to teach in a certain way or to carry out leadership activities — especially in a public way. Yet, the data from Leader Teachers suggests that while they did not feel fully prepared to carry out the reform work assigned to them, a large percentage were still trying to do it.

Why were Leader Teachers persisting in doing leadership work despite their shaky feelings about their capacities to do it? CPRE suggested two hypotheses. First, Leader Teachers believed so strongly in the goals of inquiry-based reform that they were willing to actively support it in spite of their feelings of inadequacy. For example, Leader Teachers felt that the LTI experience strongly increased their personal subject matter and pedagogical knowledge, and it is distinctly possible that this personal comfort with science allowed them to overcome their qualms about spreading the ideas in their schools.

Second, Leader Teachers felt strong personal commitment to the Partnership, which helped them overcome their uncertain feelings about their preparation. Interviews with Leader Teachers were full of statements of admiration for individuals on the MISE staff and sentiments of allegiance to these individuals.

Is training teams of teachers to be “content experts” and leaders in elementary schools an effective strategy for producing cultures of distributed leadership?

The answer is that it depends. First, it depends on the attitudes, style, and agenda of the principal. Interviews with Leader Teachers suggested that the formality of their roles in their schools was highly situational. In some schools, Leader Teachers were explicitly recognized by their principals as the science leaders in the school and were relied upon for their expertise. In other schools, Leader Teachers’ roles were strictly informal, with no recognition or support from the principal.

Second, it depends on the status, skills, and preferences of the individuals selected. The choice of who would be designated Leader Teachers was made quickly and not always appropriately. MISE asked teachers to submit applications if they wanted to become Leader Teachers, and the final selection of Leader Teachers was made by a committee at MISE. Principals provided input into the final selection. However, teachers who were new, had weak science content knowledge, and were not perceived as “leaders” already in their schools were among those selected. Because of the selection process, the Leader Teacher status was sometimes granted rather than earned which made it difficult to initially gain respect from other teachers. This made the role less legitimate which may have slowed teacher collaboration and distributed leadership. The Leader Teachers themselves were ambiguous about their roles as leaders, and most were focused on being more proficient within their own classrooms. In fact, MISE staff suggested to Leader Teachers that, in defining their roles, they should focus on their own classrooms the first year, the school the second year, and the district

the third year. In this way, teachers would have the opportunity to practice inquiry within their own classrooms, gaining confidence and skill before working with colleagues. Altering a role without also altering the formal position description may have hindered progress.

Finally, it also depends on the amount of time available for inquiry-based instruction, planning, and collaboration with peers. In the LTI follow-up survey of 1995, Leader Teachers reported that one of the biggest barriers to inquiry-based instruction was lack of time for planning and instruction. Leader Teachers stated that they lacked the time to both teach and lead well. School staff were sometimes discouraged by the effort required to schedule collegial activities without visibly violating the multiple norms to which they needed to adhere.

Overall, the strategy of using teams of Leader Teachers to stimulate instructional change across their schools has been a mixed success as it is highly dependent on the support of the principal and the careful selection of Leader Teachers.

Expanding Professional Development Opportunities

In the third year of the Partnership, MISE secured a grant from NSF's Local Systemic Change program. The grant mandated that MISE-sponsored professional development should reach approximately 80% of the teachers in the Partnership schools. This was the equivalent of engaging over 800 teachers from 34 schools in the four partner districts, over five years in 100 hours of high-quality professional development in science, mathematics, and technology.

This dramatic expansion of professional development was accomplished through the development of the PTWs. The purpose of these workshops was to train teachers in inquiry-based instruction and to further increase local capacity to support instructional reform. The content of the PTWs was determined by the district teams in consultation with MISE staff. These teams used teacher surveys, supervisory reports, and performance data to determine the areas of the curriculum that needed attention. From 1997 onward, the districts took on increased responsibility for recruiting teachers and managing the logistics of the PTWs.

Each PTW was designed by an instructional team consisting of two or more accomplished teachers (often Leader Teachers), science content specialists, district supervisory and curriculum specialists, or MISE staff. MISE supported these teams by conducting a professional development design meeting each spring and providing consultation to the teams before and during the PTWs. MISE staff also monitored the PTWs and used CPRE follow-up evaluations to identify areas needing attention. Through both summer institutes and academic-year follow-up sessions, strong relationships were built between teachers and the instructional teams, and PTWs reinforced the exchange of ideas among colleagues.

Organized as one-week summer institutes, in general, the content of the PTWs was based on the science modules used by the districts in specific grade levels. A key goal of the PTWs was to familiarize teachers with the reform-based instructional materials. Building the content knowledge of workshop participants was another major goal of the Partnership's professional development program. Teachers typically attended one workshop of their choice and also were offered two days of follow-up

during the school year. Between 1996 and 2002, the Partnership districts offered 166 PTWs which served an enrollment of 3,175 teachers. Since the total eligible population of teachers during this period, including those who left or entered the four systems, was about 1,100 teachers, this means, on average, each teacher attended about three summer PTWs. Many teachers attended five or six. Over this six-year period, the Partnership provided, on average, over 30 hours of professional development in science for each classroom teacher responsible for the teaching of science (CPRE, 2002).

The Impact of PTW Participation on Classroom Practice

CPRE researchers used a classroom observation instrument developed by Horizon Research, Inc. (HRI) for the national evaluation of NSF's Local Systemic Change project. The instrument was used to rate the effectiveness of classroom lessons and had a 7-point summary assessment in which a 1 was ineffective instruction and a 7 was exemplary. The scale was demanding, and scores of 5, 6, and 7 were considered to be high, indicating use of inquiry in the classroom. The score on the scale represents a cumulative judgment made by a single observer based on the design of the lesson, its implementation, the subject-matter content of the lesson, and the culture of the classroom.

Examining the ratings of observations conducted in the Partnership schools between 1997 and 1999 reveals that the ratings of teachers who participated in PTWs climbed steadily. In 1997, the average rating for Peer Teacher observations was 3.44. In 1998, it rose to 4.08. In 1999, the rating increased again to 4.24. Clearly, the PTWs were impacting classroom practice, and the "average" teachers who participated in PTWs were using

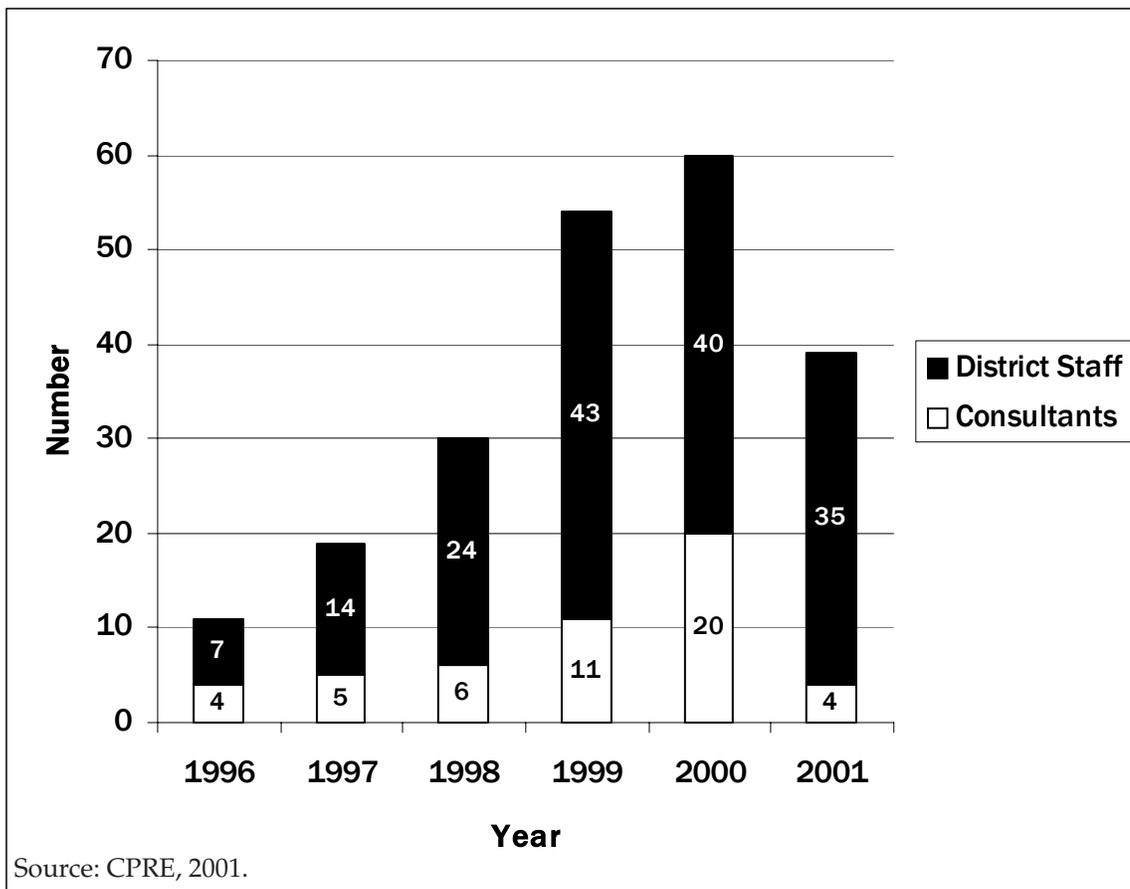
inquiry and many were doing it with considerable sophistication.

Building Teacher Leadership through the Use of Instructional Teams

From 1996 through 2001, MISE supported the development and work of the instructional teams that led the PTWs. Each team had at least three members — two experienced teachers and a content expert. Typically, the two teachers on the teams had taught the science module that was the focal point of the workshop and some had experience conducting professional development in their schools and districts. MISE staff or associates provided science expertise. The three members of the instructional teams were expected to share roles. The intention was to give the two teachers as much responsibility for the design and implementation of the workshops as the content experts had. These teams modeled the pedagogy they were working to get teachers to use, and participants conducted investigations, worked in cooperative learning groups, analyzed instructional activities against standards, and reflected on their current practices and what they were learning.

Figure 1 shows the general make-up of the instructional teams from 1996-2001. The composition of these instructional teams evolved over time; in the first few years, the teams drew heavily on MISE staff and external consultants, but also included a number of Leader Teachers. The external consultants included individuals from national curriculum development and technical assistance organizations, other science organizations, local and regional university faculties, and other school districts. By 2001, the team members for the science PTWs were predominantly teachers from the four partner districts. Thirty-five of the 39 instructional team members offering

Figure 1. Composition of Instructional Teams for Science Workshops, 1996-2001



science PTWs in the summer of 2001 were district staff including 6 from local high schools.

I feel much better prepared to implement the program, to assess it, and to share my knowledge and techniques with my peers.

The Quality of the Instructional Teams

Based on the sessions observed by CPRE staff and interviews with participants, most PTW leaders were perceived by participants as knowledgeable and skilled experts. Effective instructional team members had the potential to rekindle teachers' thirst for more content. One participant in a highly rated workshop commented:

This has been perhaps one of the best workshops I have attended because of the facilitator's preparedness, style, and knowledge of the classroom and program.

The leader of this workshop was sharing knowledge with teachers who then returned to their schools and spread what they learned. This is the type of capital (human, social, and cultural) sharing that Spillane, Hallett, and Diamond (2000) explain is a core part of distributed leadership. In this way, MISE could fulfill its goal of spreading its vision to as many teachers as possible.

The following excerpt from an interview with one of the participating teachers is typical of participants' responses:

The instructional team did a wonderful job. This is the second time that I've been in a workshop with [instructor]. She

makes us all feel that we are physicists. Certainly, all aspects [of the workshop] can be used, but I found the science content and inquiry-centered instructional techniques to be most helpful for me. Being able to revisit content in this new light helped to refresh my memory and made clearer for me the great value of using inquiry-centered methods.

CPRE evaluators interviewed instructional team teachers in order to better understand whether this strategy was improving science instruction in the districts. The results of these interviews suggest that the strategy is successful. First, the teachers reported that they were clear about the skills they brought to the instructional team and that they were satisfied with their role on the team. As one teacher remarked:

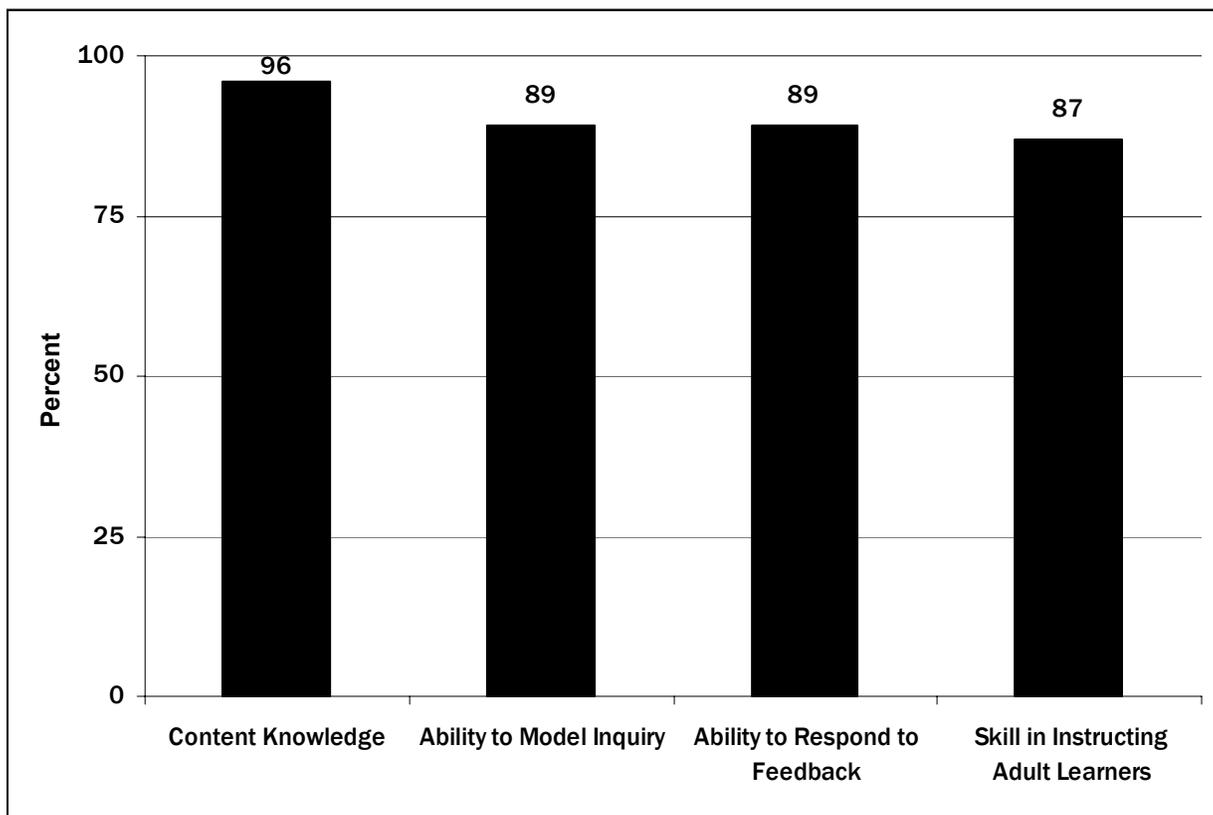
I was part of the basic decision-making process. We were given a basic framework, but we were allowed to shape

it from the ground up within our discipline, including what our themes would be and what activities we might use. We all brought to the table what we had or could find.

All of the teachers said that they were initially uncomfortable as instructors but quickly grew into the role. Teachers identified ways to encourage their colleagues to show greater initiative, and started to look beyond their own classrooms to consider how their skills could benefit their districts.

Participants completed evaluation surveys at the end of each PTW. Most participating teachers reported being highly satisfied with the PTWs across the years. Figure 2 illustrates participant responses to questions about the instructional team that led their sessions. Ninety-six percent of the participants said the instructional team’s knowledge of science instruction was either very or extremely effective.

Figure 2. Percentage of PTW Participants Who Found Selected Aspects of their Instructional Team’s Delivery Very Effective or Extremely Effective



In addition, almost 90% of the participants felt that the instructional teams were very or extremely effective in their ability to model inquiry-centered instruction, in their ability to respond to participants' questions and feedback, and in their skill in instructing adult learners.

Each year, some of the instructional team members were conducting workshops for the first time, and despite MISE's efforts to provide them with guidance and support (through an intensive three-day retreat to plan the PTWs and the inclusion of content experts on the instructional teams), there was always some unevenness in the delivery. However, the overall impression of CPRE evaluators was that only a modicum of quality was sacrificed in the short run in order to build greater district capacity in the long run. By encouraging teachers to lead workshops, MISE was simultaneously improving their teaching skills and providing potential peer coaches for the schools. MISE was continuing to distribute leadership as a way of building capacity.

Instructional Team Members as Leaders in Schools

Interviews conducted with members of instructional teams indicated that they were assuming leadership positions in their schools and districts. Many had already been playing such roles as they had been Leader Teachers, but others had not. They reported that being a member of an instructional team gave them a new status among their peers as well as increased confidence in their knowledge and skills. The experience of designing and leading professional development sessions prepared them to lead professional development in their schools. It also linked them to networks of school and district leaders who were involved in planning the PTWs for their districts and a larger network of educators who were working on these tasks across the Partnership.

One instructional team member who had not been a Leader Teacher described how her role had been transformed:

I have always liked teaching science, and occasionally when I did something that involved parents, my principal took notice. But since I have been doing the PTWs, he asks my advice all of the time, gave me a student teacher for the first time, and even asked me to do a workshop on science for an in-service day.

Another who had been a Leader Teacher said her colleagues now viewed her differently:

When I was in the Leader Teacher program, I think that some of the other teachers felt that I was trying to make myself important and resented me or just ignored me. But working in the PTWs seems to have changed how they look at me. It took awhile but they now seem to recognize that I know something about science teaching and they are coming to me for help. Two have even asked me into their classrooms to observe.

Many of the instructional team members reported a change in how they were viewed by their colleagues and an increase in requests for assistance or information. It appears that feedback about their role in the PTWs has persuaded other teachers that they have knowledge and skill that sets them apart and, as a consequence, teachers are willing to confer leadership roles on them.

Involving Principals in Instructional Leadership

While MISE focused on the development of teacher leadership, it did not neglect principals. MISE realized from the beginning that principal support was important for the success of the teacher training it was doing. Principals were involved with MISE informally in the early years. However, professional devel-

opment opportunities for school administrators were not provided until 1996. A team of principals worked with MISE staff to develop two seminars to help administrators better understand the Partnership, standards-based instruction, and strategies to support reform in science at the school level. Then there was a long hiatus in the work with principals. That hiatus, combined with considerable turnover among principals, meant that there were many school leaders who did not have deep understanding of MISE's work or the Partnership. To meet this need, a new Principals' Institute that offered an ongoing series of seminars focused on MISE's vision for instruction and on improving classroom instruction was launched in 2001.

Although MISE has recognized the critical role of principals, it has focused most of its attention on curriculum reforms, the development of teacher leaders, the provision of professional development for teachers, and district policy. As a consequence, until 2001, MISE engaged central office personnel and teachers in the work far more than it had principals. The unstated assumption seems to have been that superintendents, central office staff, and Leader Teachers would win over the principals, gain their support for the reforms in science, and provide them with whatever preparation they needed. While MISE worked with the principals at the beginning of its partnership with the four districts, providing some awareness sessions and encouraging them to attend PTWs, there was not a focused effort to prepare them to lead instructional improvements in science until 2001.

CPRE conducted an analysis that examined the relationship between several school factors, including principal support and reform-based teaching. The results showed that a conducive school environment in general and principal support in particular were the key factors that influenced reform-based teaching

practice. The importance of principal support was the most powerful finding from the analysis of school-level predictors of reform-based teaching practice. Principal support was statistically highly associated with reform-based science teaching practice. Teachers in schools with supportive principals were far more likely to use inquiry-centered practices than teachers in schools where the school leader was not supportive.

The Role of Principals and Distributed Leadership

By 2000, there had been considerable principal turnover within the districts, and a number of principals had not received the training provided in the first years of the Partnership regarding its vision of good instructional practice in science. Because of the state assessment programs, many of these new principals were focused on improving student performance in reading and mathematics and gave little attention to science. As reported above, there also was considerable unevenness in how principals worked with and supported teacher leaders. Clearly, not of all of the principals in the Partnership schools understood and practiced distributed leadership when it came to improving instruction.

In response to these concerns, the Partnership sponsored a two-day institute in June 2001 for school principals that was attended by 41 principals and some central office staff. Designed in response to a CPRE recommendation that the Partnership provide more direct training for principals, the Principals' Institute was planned by a committee of principals from the four districts and MISE and CPRE staff. MISE's session focused on the Partnership's vision of good science instruction and what to look for in the classroom. Principals were given opportunities to view, assess, and discuss science lessons. This experience

revealed the wide variation in what principals looked for in classrooms, what they valued, and how they judged what they saw.

The Principals' Institute was embraced by both new and veteran principals. One noted:

The June Principals' Institute was inspiring, helpful, motivational, useful, current, research-based. A great experience. The information was relevant to science and other disciplines. It was time to sit with our own colleagues. You rarely get a chance to do that, and actually talk about issues that affect us. Change is more forthcoming as a result.

This principal's words showed that he recognized the value inherent in building a community of practice.

By bringing principals together, the Partnership was supporting and nurturing a community of common practitioners. By following up on their interest, the Partnership could help the principals become a force for sustaining and deepening the work of instructional improvement.

Principals' Support for the Partnership

Between April and October 2001, 20 principals (15 elementary and 5 middle school principals) in the four school districts were interviewed at length. Although there were differences by district, grade level, and experience, several common themes emerged from the interviews. In general, the vast majority of principals were intellectually and pedagogically excited about the Partnership and expressed strong commitments to inquiry-based learning. They seemed to have acquired at least a general understanding of MISE's vision of good science instruction although most had difficulty distinguishing between "hands-on

science" and inquiry. They reported that teacher and student interest in science was higher than it ever had been before. It is difficult to adequately describe the principals' excitement about the effects the Partnership was having on their students and teachers. They were effusive, exuberant, and inspired by changes they had witnessed in their buildings. Principals in the partner districts were being transformed into instructional leaders. Principals recognized this change in themselves, they liked it, and attributed it to MISE.

Some principals noted:

Children love science. I love seeing hands-on, inquiry-based science. It's so cool to see the kids in action. And it's neat seeing teachers allowing kids to investigate and discover.

—Elementary school principal

What has impressed me is the professionalism and dedication to teachers learning and influencing their teaching and helping student learning. The absolute commitment of Merck! They are to be thanked. If we grab the kids and let them have fun within the learning, they're hooked.

—Elementary school principal

...we're now approaching science in a whole different way. The old textbook approach is out; students think and look at things analytically. We know how to do an observation and articulate what are in those observations. It's a pleasure to observe the science lessons. The teachers are more knowledgeable about content and process. What it does, it gives them the tools for how to learn. They're getting a philosophy of inquiry.

—Elementary school principal

It's [Partnership] had a positive effect...It's been a very effective partnership. A lot of teachers have grown. Had it not been for MISE, teachers wouldn't have tried hands-on...I had to

learn to touch the worm! And pretend that it didn't bother me. It's been enlightening.

—Elementary school principal

When one elementary school principal was asked what she sees when she observes a science class, she said:

When I walk into a classroom now, I see a lot of sharing and dialogue and excitement and the teacher roving and asking higher-level questions and having the kids ask, "Let's see what happens." A lot of charts and data collections and connections to everyday life. I'm seeing evidence of their science in the classrooms. Collaborative efforts between students. The collaborative piece, teaming with teachers, sharing discoveries, talking about their findings, sharing their scientific methods...

A middle school principal, asked for his definition of "good science instruction," answered:

I want to see student enthusiasm, content material being covered, inquiry-based. I don't expect to see lecture, upon lecture, upon lecture. I want to see experiments. I like to see kids working with each other, especially in pairs, to see challenging questions.

These interview data are consistent with the results of the HRI survey of principals in the Partnership districts. Since 1995, HRI has annually surveyed the principals in the Partnership districts. On the survey, almost all of the principals indicated that hands-on activity and inquiry were important for effective science instruction. Most said that concrete experiences should precede abstract concepts and that developing students' conceptual understanding was important. They indicated that they were willing to accept the noise associated with an active classroom and nearly 90% said that encouraging student questions was more important than eliciting correct re-

sponses. Over 90% of the principals responding said they felt well-prepared to help teachers implement the national science standards. Most importantly, over 90% reported that their schools were making good progress in improving instruction in science.

Generally, the principals wanted more involvement and more responsibility. Without the deep involvement of the instructional leaders of the schools — the principals — the program's sustainability could have been problematic in spite of the changes in district policy and the current attitudes and practices of the teachers. To truly understand the work of the Partnership, to understand the difference between "hands-on" and "inquiry-based," to know what to look for in science classes, principals needed to be included in the serious aspects of the work.

Changes in the District Leadership Culture

Changes in leadership were also occurring at the district level. MISE staff were working directly with district staff to build internal capacity, and in the process also altered the structure of leadership in the districts. At MISE's suggestion, the districts formed teams comprised of teachers, principals, and central office staff who collaborated to guide the work in each district and to develop strategic plans for improving teaching and learning in science. MISE also held biannual meetings with an advisory committee consisting of teams from each district, including superintendents, science supervisors, principals, and teachers.

MISE developed strong substantive relationships with the superintendents of the four partner districts. In all four cases, the superintendents were highly supportive of the Partnership's work. Most

superintendents participated regularly in the work of the MISE advisory committee, which signaled their active support of the initiative. Several superintendents took it upon themselves to report Partnership progress to their local boards of education. The director of MISE met individually with superintendents to discuss issues important to the Partnership, such as devising ways to formalize the leadership roles of Leader Teachers, planning ways to keep the local school boards informed about the work of the Partnership, and developing strategies to maintain the momentum of the professional development work.

MISE staff worked closely with teams from each district to develop strategic science plans focused on curriculum and instruction, student achievement and participation, policies and practices, and parent and community support. They developed strategies and identified the resources and individuals necessary to meet their objectives. This process encouraged districts to make better use of data and to think more systemically and coherently about the larger reform picture.

MISE increased the involvement of school-level personnel (principals and teachers) in district planning and decision-making. MISE respected teacher expertise and used certain teachers who were well-versed in inquiry-based science instruction as professional development leaders. Teachers were involved in developing curriculum frameworks and plans for common assessments. By recruiting additional instructional team members and providing them with training and support, MISE helped to build internal district capacity. MISE was clearly engaging many elements of the system — teachers, schools, districts, science experts, and other stakeholders — in order to build leadership. Such systemic involvement led to systemic efforts which brought about systemic change.

Summary of Major Findings

In this report, we have described the steps that MISE took to develop a more distributed model of instructional leadership in the partner schools and districts. Here we return to the seven research questions that have guided our data collection.

1. What strategies did MISE employ to develop teacher leadership in science? How did these strategies change over time?

MISE supported and helped to distribute leadership in the four partner districts from the inception of the Partnership. It began by involving teachers in district planning and then developed an intensive program to develop teacher leadership in each school. The LTI prepared cadres of Leaders Teachers who were expected to spread what they had learned to other teachers who had not participated in professional development. Although this initiative produced uneven results depending largely on the skills and dispositions of the teachers and the attitudes and style of their principals, it set the stage for a more ambitious professional development program. In the third year of the Partnership, MISE secured a NSF grant, which required that MISE reach 80% of the district teachers through professional development. This led to the expansion of professional development opportunities via PTWs and the further development of teacher leadership through the instructional teams.

MISE's strategies have changed over time in ways that allowed it to reach increasing numbers of teachers, while also establishing new expectations about the roles and responsibilities of teachers.

2. How effective were these strategies in creating new roles and increased influence for teachers? How did teachers' roles change? What obstacles or problems were encountered?

These strategies became more successful with each passing year as MISE learned from feedback provided by teachers, principals, districts, and from its evaluators at CPRE. Over time, the roles of teachers changed dramatically. Because of MISE's involvement, teachers assumed new roles as leaders and colleagues in their schools, and in the activities of the central offices. In the past, most teachers acted in isolation in their classrooms, preferring to keep their instruction private and not to share with or observe other teachers. Asking for feedback from another teacher was often perceived as a sign of incompetence. MISE changed that and encouraged teachers to continually learn from one another, especially in science. As more and more teachers were trained, they shared knowledge with one another. In short, teachers became less isolated than in the past. The teams of Leader Teachers, the study groups that worked on assessment, and the committees that planned PTWs all contributed to a cultural shift in which responsibilities are collectively shared and work is a collaborative endeavor.

Many Leader Teachers quickly assumed leadership positions in their schools, but some did not. There were several reasons that some Leader Teachers could not quickly transform into leaders. Many teachers were not appropriately selected for the LTI. In addition, their role was not often clearly defined. Leadership status for teachers during this stage was more imposed than earned. The experience of the LTI shows that training is not enough; the ground has to be prepared by working with the principal and by establishing the organizational conditions for distributed leadership.

3. To what degree were strategies successful in developing professional learning communities in science in which individuals with content expertise were enabled as leaders?

After teachers' content knowledge and pedagogical skills were strengthened, they often shared what they had learned with teachers who were new or who had not attended the trainings. This is evidenced by CPRE's findings that by the sixth year of the Partnership, most of the small minority of teachers who were not participating in PTWs also were changing their practice and using inquiry methods (CPRE, 2002). In addition, teachers formed informal networks with one another at the professional development sessions and continued to stay in contact after the sessions ended. The follow-up sessions encouraged these links as did MISE's electronic network, which included the provision of e-mail accounts, listservs, and laptop computers.

Professional communities developed both formally and informally. Teachers shared ideas in study groups, and while learning the science modules together or modeling effective techniques of inquiry-based instruction for one another. Teachers and principals were also involved in more formal types of professional communities such as the Merck advisory board meetings, curriculum framework meetings, and assessment groups working to develop common assessments. Through professional development, teachers could share human, social, and cultural capital, sharing that is necessary for distributed leadership to work. MISE was instrumental in jumpstarting the growth of professional communities, and these communities became a central path toward distributed leadership.

4. What role did principals play in this effort?

Although principals were involved in the beginning of the Partnership, it was

not until 1996 that MISE addressed their role as instructional leaders proactively. MISE arranged principal seminars in 1996 as well as a Principals' Institute in 2001 to share MISE's vision and the concept of inquiry-based instruction with them. The institutes focused on helping them understand the difficulty of observing classroom instruction and recognizing legitimate inquiry from mere activity, introducing them to coaching strategies, and helping them recognize that they needed to draw on the expertise of accomplished teachers. This investment by MISE helped principals recognize the necessity and benefit of supporting teacher leaders.

5. To what degree has MISE succeeded in changing the leadership culture in the central offices of the districts?

Many teachers participated in Partnership activities at the district level such as working on the strategic plan, designing and delivering professional development, assisting with the performance assessment pilot, serving on curriculum framework and revision committees, selecting curriculum materials, developing science pilot projects, planning school events and projects, and attending professional conferences and meetings. Through the Partnership, MISE changed the leadership structure and culture in the districts, increasing local commitment to science, building the capacity to offer professional development, and creating a new respect for teacher expertise. In some respects, the Partnership was more successful in establishing cultures of distributed leadership at the district level than it was in the schools.

6. How effective have these strategies been in altering district capacity to sustain the work and taking it to scale?

MISE increasingly involved districts in the planning and follow-up of leadership development in their schools. By 2001, local capacity had increased to the

point where the districts could sustain the planning and delivery of the PTWs and the follow-up support on their own. The districts increasingly gained ownership of the reform efforts to build teacher leaders in their community — a necessary step if districts are to sustain this work on their own. All four districts ran PTWs on their own in 2002, and are planning them for 2003. All four districts have extended this approach to supporting instructional reform to other subject areas.

The last question — what can we learn from MISE's experience about the conditions under which distributed leadership takes hold and flourishes? — deserves special attention, and therefore is the focus of the next, and final, section of this report.

Lessons Learned About Instructional Leadership

MISE's efforts to build, strengthen, and spread leadership over the past 10 years was a success. At every step of the way, MISE gathered feedback from teachers, principals, districts, and CPRE in order to learn what strategies were most useful and which had limitations.

Each year, increasing numbers of teachers were exposed to professional development and asked to spread this knowledge within their schools. MISE became more proactive over the years, while at the same time allowing districts to assume control over the design and execution of much of the professional development. Through MISE-sponsored professional development, teachers strengthened their science content knowledge and their pedagogical skills in inquiry-based instruction. Many teachers reported that collegiality within schools increased.

Elmore (2000) describes five principles underlying the concept of distributed leadership. Each principle corresponds with a strategy that MISE used, a principle that guided or drove its work, or a lesson learned along the way. These guiding principles, then, are a useful way to discuss the lessons and themes that emerged over the past decade during MISE's efforts to distribute leadership.

1. The purpose of leadership is the improvement of instructional practice and performance, regardless of role.

Through the Partnership with MISE, central office staff in the four districts became more focused on improvement of instruction and began to collaborate with teacher leaders to plan professional development and support for improvement. Instructional improvement is central to MISE's theory of leadership and this drove its work with central office staff, principals, and teachers. MISE particularly focused on developing the knowledge and skills of teachers (and principals) and moving them into leadership roles where they could champion the changes in instructional practice and culture that the Partnership was seeking.

2. Instructional improvement requires continuous learning. Learning is both an individual and a social activity.

MISE and the Partnership have based their entire strategy on the premise that continued learning and improvement of practice are fundamental professional obligations, and they have recognized both the individual and social dimensions of learning in their approach to instructional improvement. They have modeled these ideas in their own behavior by working collaboratively, by paying attention to feedback, and by making revisions to their strategy and to the people, processes, and materials that they have used.

The Partnership is somewhat unique in having a 10-year existence, so that the four partners have learned a great deal about effective professional development and supporting changes in classroom practice over that time. The Partnership has provided opportunities for individual learning but also has supported structures that brought people together to collaborate. One example is at the district level. District teams were formed that included individuals who played many different roles. Another example is the formation of the PTWs. Teachers from across schools participated in the PTWs and then reconvened as networks within schools. A central force behind the PTWs was to reach many teachers and bring them together — within and between schools. Another structure that enabled collaboration was the LTI which trained a cadre of teachers who shared knowledge with peers in their schools. Also, teachers participated in study groups that developed new assessment tools.

Teachers became more comfortable with collegiality, communicated more openly, and became less afraid of exposing their teaching styles and concerns to peers. The PTWs enabled teachers to engage in collective learning which is such a critical part of successful systemic change. Elmore (2000) makes an important point that “privacy of practice produces isolation; isolation is the enemy of improvement” (p. 20). MISE also valued bringing teachers together and making them more interdependent.

3. Learning requires modeling.

Elmore (2000) emphasizes that leaders need to model techniques, as well as desired values and behaviors. MISE used skilled teachers and experts in the field as instructors for the teacher professional development. These teachers shared human, social, and cultural capital with teachers, who then spread this capital to other teachers in their schools. As dis-

cussed before, teachers became more comfortable modeling instructional techniques for one another in order to change instruction. Modeling and other forms of sharing were a means to this end (inquiry-based instruction) and the need for privacy or fear of judgment was outweighed by the collective good.

In the early years of the Partnership, what was missing were similar opportunities for modeling of leadership for principals. This gap was addressed through the Principals' Institute, which provided principals with opportunities to see good practice and internalize it.

4. The roles and activities of leadership flow from the expertise required for learning and improvement, not from the formal dictates of the institution.

MISE encouraged districts and schools to make effective use of teachers' expertise. By preparing teachers to be leaders in schools, by involving teachers in district planning and development activities, and by using accomplished teachers to lead professional development, MISE altered perceptions about what kinds of expertise were needed and who possessed them.

During the LTI, teachers were not always selected into leadership positions appropriately. MISE asked principals for input into final selection of Leader Teachers. Some Leader Teachers who were chosen were new to the school or the teaching field, or had no knowledge of science. When leaders had been poorly selected, their leadership status seemed more imposed than earned, and other teachers did not perceive them as leaders. Some teachers lacked content knowledge and leadership skills, and change was not as likely to occur. Later on, schools and districts chose leaders based on their expertise — using experienced or skilled teachers as instructional team members.

5. The exercise of authority requires reciprocity of accountability and capacity.

According to Elmore (2000), accountability for change needs to be reciprocal. The leader needs to know how to do what is expected of the learner and needs to model what is expected. In its early years, the Partnership focused on the capacity of the Leader Teachers but did not work with principals to define what Leader Teachers would be held accountable to do. As a consequence, the role of the Leader Teachers was somewhat vague. These teachers were taking on new responsibilities and felt pressure to fulfill an ambiguous role. In some instances, the principals and Leader Teachers worked out this reciprocity and Leader Teachers were delegated the authority they needed to do the work expected of them. In other sites, the Leader Teachers lacked the knowledge, skill, or social status to carry out these responsibilities. In still other instances, their principals simply did not give them the authority or support that they needed to do the work. The principals who were being held accountable for performance were unwilling to share their authority with those who had the capacity to help others improve instruction. However, MISE was more successful in defining the roles of instructional team members in the PTWs, and this strategy did contribute to the development of distributed leadership in some schools and in the districts.

Overall Summary

In sum, MISE has learned over the past decade that distributed leadership — both in schools and in districts — works. It produces good results as measured by the quality of the professional development and the curriculum and assessment tools produced, the successful recruitment of teachers into intensive professional development, and the emergence

of teacher-led professional communities within and across the schools. MISE had considerable success in introducing distributed leadership at the district level. Initially, they simply required it, but over time, the value of teacher expertise became apparent to district leaders and the norms of leadership changed. It seems unlikely that these districts would abandon the new patterns of decision-making that have developed.

But MISE also has learned that distributed leadership can be difficult to put into place in schools. In the schools, the effects of the Leader Teacher program and the PTW program on patterns of leadership were somewhat uneven. In many of the 34 schools, distributed patterns of leadership pre-existed the Partnership but were strengthened by its activities. In some, new patterns of distributed leadership emerged and appear to be continuing, but in some others, distributed leadership has not replaced more traditional hierarchical forms.

The experience also shows that a supportive environment has to be created which means preparing the principal for working with expert teachers, and also introducing the concept in a manner that is acceptable to the school staff. The MISE experience shows that this requires careful selection of individuals for various leadership roles — teachers should be chosen appropriately based on individual level of knowledge, skill, or experience. In addition, continued support of leaders is required. The investment in people as leaders should be long-term for the sake of the individuals as well as the reform. Lastly, school administrators should be involved early on. It is clear that introducing distributed leadership into a school requires the active support of the principal. The best-trained and most-skilled teacher experts/leaders may not be able to carry out their roles if they do not have support from their administrators. The principal can be involved in

instruction and the teachers can become leaders, yet the principal is still a central source of inertia in the building.

Over the past 10 years, MISE has strengthened the connection between leadership and instruction in the Partnership districts and schools, and the structures for supporting instructional improvement are more robust and more effective as a result. As Elmore (2000) argued, instructional change can occur only if leadership in the school will support such change.

MISE has succeeded in developing distributed leadership through its systemic approach to the reform of science instruction. Teachers' content knowledge and pedagogical skills improved, they were recognized as leaders in their schools and in their districts, and principals became more involved in instruction. Elmore (2000) observes that distributed leadership has not been the dominant model in most public school systems despite much research showing the value of this kind of model. The MISE experience shows that the dominant model can be changed, and that the change is worthwhile.

References

Consortium for Policy Research in Education (CPRE). (2001). *Steady work: A report on the seventh year of the Merck Institute for Science Education, 1999-2000*. Philadelphia: Author.

Consortium for Policy Research in Education (CPRE). (2002). *A report on the eighth year of the Merck Institute for Science Education, 2000-2001*. Philadelphia: Author.

Elmore, R. F. (2000). *Building a new structure for school leadership*. Washington, DC: The Albert Shanker Institute.

Newmann, F. M. (1996). *Authentic achievement: Restructuring schools for intellectual quality*. San Francisco: Jossey-Bass.

Spillane, J. P. (1999). *Distributed leadership: Toward a theory of school leadership practice*. Evanston, IL: Northwestern University.

Spillane, J. P., Hallett, T., & Diamond, J. B. (2000, April). *Forms of capital and the construction of leadership: Instructional leadership in urban elementary schools*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2001). Investigating school leadership practice: A distributed perspective. *Educational Researcher*, 30(3): 23-28.

Stricherz, M. (2001, September 12). Principals' training designed to boost instructional leadership. *Education Week*.