The Merck Institute for Science Education: An Intermediary for Education Reform

Carlo Parravano

In 1992, when I was on the chemistry faculty and chair of the Division of Natural Sciences at the State University of New York in Purchase, New York, leaders of Merck and Co., Inc. discussed with me a new initiative they wanted to undertake. Merck wanted to create a non-profit organization that would work with public school districts to raise the interest, participation, and performance of public school students in science. I was approached about being the founding director because of my prior experience building partnerships between higher education and local school districts, including developing and offering summer workshops for science teachers in school districts near the University. After talking with Merck executives, I became convinced that Merck had a deep understanding of the issues around science education reform; that they knew this kind of reform would take a great deal of time, work, and focus; and that they would back the institute long-term. At the highest level of the company, there was a strong commitment to reforming science education. Merck had a long and proud history of being a good neighbor to the public school districts near its facilities. The goals of Merck aligned closely with my own commitment to improving science education for all students, and so I took advantage of this unique opportunity.

The Merck Institute for Science Education (MISE) was created in 1993, backed by $20 million and an initial ten-year commitment from Merck to improve science education. MISE began by forming partnerships with four public school districts in areas where Merck had major facilities: Linden, Rahway, and Readington Township in New Jersey, and North Penn in Pennsylvania.

What follows is a brief overview of the initiative, followed by a description of key decisions and strategies that contributed to the scale-up of science reform in the partner districts. The chapter concludes with some lessons learned about scaling up and sustaining curricular and instructional reforms.

Overview of the MISE Partnership's Work

From the beginning, MISE operated from an explicit theory of action for building district capacity to improve science teaching. The theory of action consisted of the following components:

- Develop a shared vision of strong science teaching;
- Develop new curriculum frameworks for science;
- Design and support high-quality professional development for teachers;
- Develop instructional leaders in science;
- Adopt and develop science assessments that inform teaching;
- Develop a district professional community around science; and
- Respond to and influence policymakers at all levels.

Looking at the first component, we (leaders of the MISE initiative) believed that the development of a shared vision of strong science teaching was paramount. A clear, shared vision fosters both efficiency and coherence; all of the reform efforts can be considered in relation to that vision. Once the vision was developed, next steps in the theory of action were to develop new curriculum frameworks; design and implement high-quality professional development for teachers; create a cadre of science instructional leaders; and develop science assessments that informed teaching. Through enacting these initial components of the theory of action, a district professional community was developed around science instruction. The final component, responding to and influencing policymakers at all levels, was critical for expanding the vision and ensuring it had support from bottom to top.

This theory of action led to a number of events and activities over the next ten years. We began by sponsoring a leadership team from each district to attend the 1993 National Science Resources Center's (NSRC) Elementary Science Summer Leadership Institute in Washington, DC. Here, the leadership teams developed a five-year strategic plan for reforming science education. After the NSRC Institute, MISE staff helped district teams begin reviewing science modules to assess their suitability for inquiry-centered teaching. These modules would form the core of the new science curriculum. Also at this time, an advisory committee was created composed of key leaders from each district to set the direction and priorities for the Partnership.

The MISE Partnership began its professional development work in 1994 with Leader Teacher Institutes that offered intensive professional development to selected teachers over a period of years to develop their knowledge and skills, and prepare them to be leaders. Later, with a federal Local Systemic Change grant, the Partnership offered professional development workshops (called Peer Teacher Workshops) on specific science modules to any K–8 teacher who wanted to attend. Three-day design retreats were held annually for instructional teams to design the Peer Teacher Workshops. To ensure that principals supported teachers as they implemented what they had learned, a series of institutes was held for principals.

In addition to professional development, MISE assisted the districts in developing science curriculum frameworks; and the Performance Assessment Project supported teacher study groups to develop and test performance tasks for classroom use. Finally, MISE contracted with the Consortium for Policy Research in Education (CPRE) to conduct a longitudinal, formative evaluation of the project.

Going to Scale: Key Decisions and Strategies

When researchers and reformers talk about "going to scale," there is a tendency to think in terms of discrete strategies or events. In reflecting on MISE's work, however, I find myself thinking not only of strategies, but of *decision points*. The focus of this case study, then, is not only on what we did, but also on key decisions that helped take the reform to scale. This section begins with a discussion of two key decisions that shaped the work from the beginning: focusing on the district, and approaching the reform systemically. Key decisions are then discussed in the context of two important strategies used by MISE to scale up the reform: (1) creating a shared

vision and a system aligned to that vision; and (2) increasing teacher knowledge and skills. This section concludes with another key decision: working with a policy research organization to determine if our efforts were having the desired effects.

Key Decision: Focus on the District as the Unit of Change

Focusing on the district as the unit of change was a conscious decision from the beginning. When that decision was made in the early 1990s, most of the work that had been done in reforming science teaching had focused on the individual teacher—with a few projects focused on the school as the unit of change. The Partnership's decision to focus on the district certainly didn't mean that we ignored schools and teachers, but we conceived of this work as district-wide science education reform. In a way, the decision was made for us. Because a major corporation was involved in this Partnership, the superintendent was automatically involved. Partnering with Merck was something districts wanted to do—it was a victory for the superintendent and school board to establish this prestigious Partnership. Because we were working with entire districts, the science reform was a part of district culture from the beginning, which helped maintain buy-in as new leaders came into the districts. Approaching the reform at the district level also helped later when the districts had to assume more responsibility for funding. The districts were committed to the reform for all schools, and MISE did not have a situation of individual principals competing for limited district resources.

Key Decision: Approach the Reform Systemically

Related to the district focus was a decision to approach the reform systemically within and across the partner districts. At the time this work was launched in the early 1990s, there was a great deal of attention to what systemic reform looked like at the state level (Fuhrman, Elmore, & Massell, 1993; Smith & O'Day, 1991). MISE applied those ideas by focusing on what systemic reform should look like at the district level, including deciding what the pieces of the work would be and how those pieces would be integrated. Toward that end, we developed a list of key components of systemic reform at the district level—a list that reflected our theory of action. The components were:

- Adoption of ambitious goals and more challenging academic standards for all students;
- Development of a broad consensus on the vision for the schools and classrooms that will enable students to reach these higher standards, and a language for discussing and reflecting on the vision;
- Development of more coherent local policies (finance, curriculum, assessment, and professional development) in support of the goals, standards, and vision;
- Development of curricula reflecting the standards, emphasizing more rigorous content, higher-order thinking skills, problem-solving, and the integration and application of knowledge;

- Development of performance measures to assess students' understanding of essential content, their ability to apply it to solve problems, and their capacity to integrate knowledge across the disciplines;
- Development of capacity to motivate, prepare, and support the efforts of teachers and administrators to make the changes envisioned in curriculum, pedagogy, assessment, and school organization; and
- Building public awareness and support for the reforms in order to reduce the risks (real or perceived) of local educators attempting to implement them.

This systemic approach to district reform made clear the full range of the work involved. Up to that point, districts may have thought all they needed in order to change science instruction was new science kits and workshops for teachers. This plan for local systemic reform provided a more complete picture of what the Partnership would have to do to be successful. The system focus also opened the door for involving a broader range of people. Had the focus been strictly on introducing new science kits, MISE would have worked only with the people who would buy and implement the kits. Instead, we found ourselves working with superintendents, curriculum coordinators, and principals, as well as with teachers.

Key Strategy: Align the System in Support of a New Vision of Science Instruction

As is generally the case in elementary science instruction in the United States, science in the Partnership districts was generally taught by teachers with very little background in science. In addition, science was often a neglected subject, something that could be canceled for the day if other activities consumed more time than intended. At the time MISE began its work, neither New Jersey nor Pennsylvania assessed students in science, so reading, writing, and mathematics took priority. When science was taught, there was a heavy dependence on textbooks. MISE's initial task, then, was to help the school districts develop a new vision of science education, along with plans for putting the vision into practice.

A *key decision* that helped accomplish this initial task was to sponsor leadership teams from each district to attend the National Science Resources Center Elementary Science Leadership Institute in Washington, DC. The institute focused on the selection of inquiry-centered sequential science curriculum units, professional development to prepare teachers to use inquiry-centered methods, cost-effective support systems for supplying materials, assessment methods, and strategies for building administrative and community support. The decision to send teams to this institute was instrumental in sharing and building the vision, and it got the districts moving because each team spent time at the institute developing a five-year, strategic plan for reforming science education. Within these plans districts specified: What are the tasks? What are the tools that we need? What are the roles? The components of the districts' strategic plans (i.e., professional development, assessment, selection of instructional materials, and materials management) continue to organize the science programs in the partner districts.

Creating a system that aligned with the new vision of science reform required the Partnership to clarify and spread the reform vision throughout the partner districts (not just among the people

who attended the NSRC institute), provide instructional materials to support the vision, and build support among key leaders and stakeholder groups. Each of these strategies is discussed below.

Clarify the Reform Vision

MISE has been explicit about our vision of science instruction, and we have been true to that over the years. This vision is best summed up in our program materials: "The work of MISE with its partner districts is guided by a vision of science classrooms in which inquiry is an integral and regular part of the learning experience of all students. Inquiry-centered teaching and learning imitates the thinking and methods of scientists to help students explore and understand the natural world. The Institute's approach to instructional reform rests on the premise that when students are engaged in legitimate inquiry, they develop a greater interest in, and deeper understanding of, science than is possible through more conventional instructional approaches." Initial attendance at the NSRC Leadership Institute laid the groundwork for clarifying this reform vision, and all subsequent activities of the MISE Partnership have reinforced the vision.

The vision of inquiry-centered learning encouraged by MISE was perhaps more practical than that envisioned by some reformers, who would suggest that students identify topics and design their own methods for exploring those topics. MISE chose instead to encourage districts to adopt existing science modules that were inquiry-based and in alignment with state and national science standards. In this way, we hoped to give teachers and schools the structure they needed to succeed in implementing a new vision of science education.

Provide Instructional Materials to Support the Vision of Teaching and Learning

MISE sought a transformation from textbook-based, memorization-oriented instruction to guided inquiry in which students actively engage in science investigations based on structured curriculum units such as those developed by the Full Option Science System (FOSS), Science and Technology for Children (STC), and Biology Sciences Curriculum Study (BSCS). We hoped to persuade districts to adopt well-designed, commercially-available science modules that would cover key standards and support inquiry or investigations guided by teachers. Upon returning from the NSRC institute, MISE staff worked with district teams to review science modules and select the ones that were suitable for inquiry-centered teaching and that supported the science standards. The districts selected modules that were in line with the shared vision of inquiry-centered science. MISE created a resource center that loaned science modules to districts to help teachers make a final selection. We then assisted the districts in purchasing the instructional materials. In this way, we insured that teachers had all the materials they needed to implement the reform.

Cultivate the Support of Key Leaders and Stakeholder Groups

MISE gained the support of key leaders through the Partnership Advisory Committee, and through Principal Institutes. The advisory committee is composed of teams from each district including the superintendent, district curriculum personnel, "Leader Teachers" (more details below), and principals. This committee sets the direction and priorities for the Partnership, and keeps district leaders intimately involved with the work. Since the project began, there have been a significant number of leadership changes in the school districts. Each time these changes have occurred, there has been a concerted effort to make new leaders aware of the work of the Partnership and how they can support it.

Regarding principals, initially MISE introduced principals to the science standards and the vision of reformed practice and worked with them on the effective use of Leader Teachers in their schools. But during the middle years of the work, MISE focused more on engaging central office personnel, with the rationale that the central office and Leader Teachers could win over principals. Feedback from the field, however, indicated that some principals were less than supportive. Also, as principals turned over, some of the new principals had only vague notions of the instructional vision of MISE. As a result, during 2000–01, MISE convened a representative group of principals from the four districts to discuss what could be done to better prepare principals to support the vision of quality science instruction. The result was a professional development program that focused on distributed leadership, what to look for in science classrooms, how to make effective use of accomplished teachers, and supporting teacher learning on the job. Four, two-day institutes were held, and principal responses were overwhelmingly positive.

Key Strategy: Increase Teacher Knowledge and Skills

Another key strategy for MISE's work was increasing teacher knowledge and skills in the area of science education. A *key decision* in determining how to best accomplish this was to design and deliver our own professional development. Initially, the institute intended to serve as a broker for professional development, with entities such as colleges and universities actually providing the professional development. After conversations with numerous advisors, however, MISE was persuaded that we should work with the school districts to develop a model of professional development. Having made that decision, a number of strategies were adopted that proved to be important to the scaling up effort, including developing teacher leaders, identifying core principles to guide the professional development, offering professional development to *all* teachers, providing incentives for teacher participation, and ensuring quality implementation. Each of these strategies is discussed below.

Identifying Core Principles to Guide our Professional Development

In deciding to offer our own professional development, MISE made a commitment to offer experiences that were consistent with what the research had to say about effective professional development. We adopted a set of guiding principles to ensure that the professional development would be of the highest quality. These guiding principles ensured that the professional development would be:

- Based on a clear vision of good practice;
- Linked to specific curriculum units and focused on the content teachers must teach;
- Carefully designed and planned to provide knowledge of skills that were immediately useful in the classrooms of the participants;
- Respectful of teachers and based on a coherent theory of adult learning;
- Intensive, but also extended over time through on-site support to allow for practice and reflection;
- Led by accomplished teachers who modeled good instructional practice and collaborative work;

- Easily accessible for all eligible teachers; and
- Sustainable over time by local districts.

Develop "Leader Teachers"

A standard phrase in the professional development community today is "teachers teaching teachers." The Partnership made the decision early on to seek out teacher expertise within the districts and to continue to build that expertise over time. We wanted to honor the expertise of teachers, but at the same time encourage new learning. We did this through the Leader Teacher Institutes. Three or four teachers were selected from each K–8 school, and these "Leader Teachers" were immersed in professional development for a three-year period. During that time, they attended three-week summer institutes for three consecutive years, with multiple day-long follow-up sessions during each school year. Each year, the focus was on a different domain of science—biological, physical, or earth science. These experiences were intended to enhance participants' knowledge of science content and their skills in inquiry-centered teaching and to prepare them to be leaders in their schools and districts. It is very unusual, even now, for teachers to spend that much time in professional development.

The immersion of Leader Teachers in science content, inquiry, and leadership was a very important starting point to building capacity. The Leader Teacher Institutes helped create a single partnership among the four districts, as more than 140 teachers from the four districts participated in common professional development over a three-year period. A lasting bond was formed through the commitment of MISE, the four districts, and the Leader Teachers to this ongoing professional development experience.

Offer Professional Development to All Teachers

Earlier, I noted that MISE deliberately focused on the district as the unit of change. That decision helped ensure that we would address problems such as policies not aligned with the Partnership's vision that might get in the way of improved science instruction. But we also recognized that meaningful reform required developing the capacity of classroom teachers to implement the vision.

In 1995, a five-year Local Systemic Change grant from the National Science Foundation enabled the Partnership to provide more teachers with direct access to professional development. Peer Teacher Workshops were created as week-long workshops around specific science modules that the districts were using to anchor their science curricula. The workshops were designed to help teachers understand the content of the modules and common student misconceptions about the concepts presented. There was also a heavy emphasis on helping teachers use inquiry in the classroom. Teachers were encouraged to attend the workshops in grade-level teams, which helped build professional learning communities in the schools around the vision of inquiry-based science. The workshops were designed by instructional teams that included Leader Teachers, MISE staff, faculty and representatives from local universities, and representatives of curriculum development organizations. Several Peer Teacher Workshops were offered each summer. For instance, in a given summer there might be a workshop for 3rd grade teachers on the FOSS "Water" module, another for fourth-grade teachers on the STC module "Rocks and Minerals," and yet another for fifth-grade teachers on the STC module "Motion and Design."

Participation in the Peer Teacher Workshops was open to all K–8 teachers in the Partnership districts on a voluntary basis, but the goal was to provide at least 80 percent of the teachers in the four partner districts with 100 hours of this kind of professional development over a five-year period. Teachers could attend multiple workshops during the summer (each focusing on a different science module), and they could participate in the workshops year after year. During 1999, 2000, and 2001, about half of the K–8 teachers teaching science and/or mathematics in the partner districts had participated in the workshops. By 2002, over 80 percent had participated.

The Peer Teacher Workshops were critical in maintaining the focus on science and in spreading reform throughout the districts. In addition, the workshops helped meet the districts' needs in providing professional development to increase the science knowledge and skills of district teachers, many of whom had fairly weak backgrounds in science.

Over time, as teachers developed expertise in various science modules, the Partnership began to offer several levels of Peer Teacher Workshops. For example, there is now a series of workshops for teachers who have not had much experience in teaching the materials, with the focus on familiarizing teachers with the student activities. Another level is comprised of teachers who have taught the materials for several years; for these teachers, there is a much greater focus on the science content that undergirds the modules.

Provide Incentives for Teachers to Participate in Professional Development

A number of incentives were inherent in or built into the project to encourage teacher participation in professional development. For those participating in the Leader Teacher Institute, one incentive was the opportunity to learn and influence policies in their schools and districts. These teachers could also receive academic credit from local colleges and universities, as well as stipends provided through an NSF grant and MISE. MISE also paid stipends initially for teachers to attend the Peer Teacher Workshops. While there may have been some peer pressure for teachers to attend workshops, there was no link between teacher evaluation and participation, so Peer Teacher Workshops were not seen as high-stakes or threatening.

Even with incentives in place, MISE had difficulty initially achieving the 80 percent participation rate envisioned. Project leaders asked the external evaluator, the Consortium for Policy Research in Education (CPRE) to conduct a study of non-participating teachers to help identify ways to increase participation. CPRE surveyed participants and non-participants, and found three crucial areas in which the two groups differed: enjoyment of teaching science, preparation to teach science, and conceptions of professional development. Teachers who had participated in Peer Teacher Workshops reported greater enjoyment of science and better preparation to teach it than did non-participants. While we did not feel we could have a great deal of influence on these attitudinal differences, we did see some potential to learn from the third area of difference: conceptions of professional development. Survey results showed that non-participants preferred short professional development experiences and were reluctant to commit a full week to professional development. They also viewed effective professional development as the sharing of information by an interesting instructor rather than actively exploring science content and ideas. Non-participants also preferred professional development in content areas other than science, and preferred to attend activities during or shortly after the close of the school year and near to their homes.

In response to these findings, MISE expanded the offerings to include some choices not linked directly to specific science modules, such as integrating technology into science instruction, and integrating science and language arts. Workshops were also scheduled immediately following the close of the school year. After these changes, 34 percent of teachers who had not previously participated signed up for Peer Teacher Workshops; eventually, two-thirds of teachers who had not participated the first three years enrolled in the workshops (Corcoran, 2003).

Perhaps the greatest incentive for participation has been that the professional development has been seen as so valuable to teachers, schools, and districts. CPRE evaluators consistently reported that the quality of professional development was high, and that workshop leaders were skilled and knowledgeable. Over the course of the work, the average teacher received 132 hours of professional development. In 18 of the 35 Partnership schools, over 80 percent of teachers participated in at least one Peer Teacher Workshop. These numbers suggest that there were sufficient incentives to encourage teacher participation.

Ensure Quality Implementation

One of the *key decisions* made by the MISE Partnership that helped ensure quality implementation was to recruit successful Leader Teachers to help design and deliver Peer Teacher Workshops. From the time these workshops were launched, MISE prepared and supported three-to-four-person "instructional teams" who planned and refined the workshops through an annual, three-day design retreat held in the spring. Initially, the instructional teams drew heavily on MISE staff and external consultants from curriculum development and technical assistance organizations, as well as universities. Leader Teachers were always included on the instructional teams, but over time, the teams were predominantly recruited from Leader Teachers and other staff in the partner districts, which helped build capacity to scale up the reform.

The annual instructional team retreat for designing and refining the Peer Teacher Workshops contributed to scaling up because it provided a way to ensure that the vision of science reform was kept at the forefront and shared by all presenters. The retreats focused on everything from what it means to teach adult learners, to the science content teachers need to teach specific modules, to appropriate pedagogy and pedagogical content knowledge, to the use of particular instructional strategies. The retreat continuously changed and improved, and was something in which the Partnership invested a great deal of time and thought. As we moved from five-to-seven Peer Teacher Workshops to 30 workshops a summer, we ensured quality implementation through the instructional team retreats.

Key Decision: Working with a Research Organization to Determine if the Reform Was Having the Desired Effect

A critical decision for the project was to build in an evaluation from the beginning. In my last interview before coming to Merck, the CEO asked, "How are you going to measure that you have made a difference?" Merck officials wanted to make sure we had a handle on impact; not necessarily that the program would be successful—although everyone wanted that—but how are we doing, have we done the right things? Making the decision to have an ongoing, longitudinal evaluation was the first part of this key decision. It is very unusual to have a ten-year evaluation of a project, and I think this shows Merck's commitment to measuring the impact of the program.

Throughout the project, researchers from the Consortium for Policy Research in Education (CPRE), headquartered in Philadelphia, interviewed teachers and district leaders, surveyed teachers, developed school case studies, and analyzed student achievement data. They provided regular, ongoing feedback to MISE staff, which we often used to make adjustments to the program. I cannot emphasize enough the impact that the evaluation has had on the work, but also on building a community of learners.

One method used by CPRE to determine if the work of the Partnership was having an effect on teacher practice was to look at the statistical relationship between reform-based teaching practice (as reported by teachers and principals on surveys) and professional development provided through the Partnership, while controlling for teacher background and school characteristics. The results showed a very strong relationship between high levels of professional development and reform-based teaching practice. Teachers with 80 or more hours of professional development reported using significantly more reform-based practices than those with fewer than 80 hours. In addition, classroom observations by CPRE researchers found that both Leader Teachers and teachers who had participated in the Peer Teacher Workshops had changed their practices, and were using the science modules to engage students in inquiry-based instruction. Both groups of teachers were above average in their use of inquiry, using an observation instrument developed by Horizon Research for the NSF Local Systemic Change evaluation (Corcoran, 2003).

CPRE also attempted to determine if participation in the MISE Partnership had improved student performance in the partner districts, but encountered numerous challenges finding an appropriate way to measure this sort of impact. This issue will be discussed in greater detail in the next section.

Lessons Learned

The MISE Partnership is an example of science education reform that has been scaled up within the districts in which it was implemented and is now expanding to other school districts. In the previous section, I shared my thoughts on key decisions and strategies that contributed to scaling up. In reflecting on these decisions and strategies, I would also like to share a number of lessons learned in our project about scaling up instructional and curricular reform.

LESSON 1: Professional development is necessary, but not sufficient for improving teaching and learning.

Professional development was the centerpiece of the MISE Partnership, but we did not rely exclusively on professional development to change classroom practice. Teachers need a variety of other kinds of support as well. Given the numerous demands on teachers' time, project leaders believed it was critical to provide teachers with good curriculum materials to help them implement standards-based, inquiry-centered science instruction. The materials resource centers helped provide the materials and keep them up-to-date. The Partnership also provided teachers with support in the form of Merck employee volunteer programs and parent involvement programs to ensure a base of parent and community support for this new way of teaching. The strong involvement of district administration in the reform also ensured that teachers had support from the highest levels.

LESSON 2: Meaningful change takes time and persistence.

MISE has been working with the four partner districts for more than a decade because we learned that it takes time for teachers to build the knowledge and skills they need to change their practices. The long-term presence of the MISE Partnership also helped keep the districts focused on science education reform in the face of competing demands.

LESSON 3: Development of a local support system increases the sustainability of the reform.

Even though MISE made a long-term commitment to the partner districts, the ultimate goal is for the districts to assume responsibility for the reform. This will only happen if a local support system is in place. MISE helped develop a local support system in several ways. First, because the project included the development of Leader Teachers, there were many individuals in the district and schools who were knowledgeable about the reform, and who could provide support. Because districts saw how important this work was, several of the partner districts now fund individuals whose sole responsibility is to help support classroom teachers in their science instruction.

Second, MISE purchased science modules, and each district assumed responsibility for refurbishing the modules. The districts have shown a strong commitment to keeping these materials centers going. In the North Penn school district, for instance, the materials center has migrated a couple of times because the district needed space for other things, but each and every time, the center has landed in a good spot. The Linden school district opened a new science materials center in Fall 2006.

The very strong partnership among the four original school districts has continued over time and has assimilated two new districts. All of the professional development planning is common, the delivery is common among the New Jersey School districts, and there is a great deal of sharing of professional development opportunities. We also link districts through sharing data from the evaluation, which has built ownership and buy-in. The evaluation was not designed to pit the districts against each other; it was designed from the beginning as an evaluation of the Partnership. Everyone is linked together around a table looking at data and deciding how to improve. Districts are asking themselves individually and collectively, "What do we need to do in order to be successful?"

LESSON 4: Involvement of an external organization can help keep science a priority.
The fact that the Merck Institute for Science Education institute has made a long-term commitment to working with these districts has in many ways been a real buffer from competing demands. The fact that improvement of science instruction has remained a priority in the districts, even with pressures to focus on reading and mathematics scores, is due in large measure to the work of the Partnership. Over the life of the project, new superintendents have come in and there have been changes at the state level. One constant over the last 12 years has been the work of the MISE Partnership. New superintendents, principals, science supervisors, or teachers arrive with their own sense of the importance of professional development in science, and what it should look like. The long-term presence of the Peer Teacher Workshops attests to the culture of science professional development in the partner districts. These workshops send the message to incoming administrators and teachers, "This is the way we do business in science education." A new superintendent in one of the districts, even before he came on board, went to the Peer Teacher Workshops. Doing so gave him a strong sense of the importance of science education and of how the school district approaches and supports science professional development.

LESSON 5: Required resources need to be available on an on-going basis.
The Partnership has been very fortunate to receive two grants from NSF that helped move the reform forward: first, the Local Systemic Change grant and now, a Mathematics and Science Partnership grant. The third source, of course, is The Merck Company Foundation, which continues to provide resources to MISE. These resources have been critical in getting the reform effort off the ground. However, the goal has always been, and continues to be, that the districts will increasingly take over the responsibility for sustaining improvement in science teaching and learning.

MISE has helped obtain the required resources in three ways. First, we worked with the districts to make sure that funding of the science program was on solid footing. The financial resources that are used to fund the science program are resources that are normally in the budget, so they are sustainable. At this point, the partner districts have not assumed total responsibility for funding the science program, but they have taken over a substantial portion of it. For example, MISE helped the districts purchase the instructional materials, but the districts have continued to refurbish them. Also, teacher stipends to attend summer workshops, initially paid by MISE, are now offered by the school districts.

When the Local Systemic Change grant ended in 2001, the four districts continued to offer Peer Teacher Workshops, with some modest support from MISE. Also, the districts have begun to offer workshops in other content areas that use the design of the Peer Teacher Workshops. Each of the four districts has a cadre of teachers who have designed and led these workshops and now have the capacity to offer quality professional development within their own district. Some Leader Teachers now serve as coaches and curriculum leaders in their districts. Thus, not only have the school districts begun to assume the financial responsibility for science education reform, but they have at their disposal human resources in the form of teachers who were trained through the MISE Partnership.

LESSON 6: It is important to assume the challenge of demonstrating that the reforms are having the desired impact on students.

New instructional materials, professional development for teachers, aligned policy, etc. are all intended to help achieve the vision of quality science instruction, but the bottom line is improved student achievement in science. The Partnership has worked very hard to demonstrate improvement in student achievement in science over the years of our work, but the challenge has been to find assessments that are stable, that are sensitive to inquiry-based science, and that schools and districts are willing to administer (if the tests are an add-on to state requirements).

MISE project leaders and CPRE researchers found the available measures of science achievement to be inadequate measures of the effect of inquiry-based science instruction. Initially, we used the SAT-9 science assessment along with the New Jersey Elementary School Performance Assessment (ESPA) to measure the impact of our work on students. The results of these assessments were mixed, and of questionable value for a variety of reasons. First, districts were reluctant to administer the SAT-9 in a widespread manner because of concerns about over-testing. As a result, only small groups of students were tested, and the test was not always taken seriously by teachers or students. Second, problems with the ESPA included the fact that it was not possible to determine how well the test aligned with the Partnership's science modules because the state did not release test items. In addition, the ESPA was eliminated during the project.

The evidence we did gather indicated that students receiving science instruction from teachers who participated in Partnership professional development over several years outperformed students whose teachers had only one or no years of MISE training (CPRE, 2003). In addition, district staff and teachers reported that student work, interest, and understanding of science had improved (Corcoran, 2003).

To respond to the problems finding a suitable assessment, the MISE Partnership in 1998 developed a four-part plan to improve science assessment. The partners agreed on the importance of using a nationally-recognized standardized measure, but also wanted to collect assessment information that was more closely aligned to the science modules they were using. The Partnership's four-part assessment plan included a nationally recognized, standardized assessment; a set of tasks tied more closely to the districts' curricula; pre- and post-assessments for each science module; and informal, unit-based assessments for classroom use.

The Partnership has encountered ongoing challenges in the assessment components that are more standardized because each district selected different science modules covering different content; and because rotation of the modules within the districts means that different schools and classrooms are teaching the content in different sequences. Components 3 and 4 of the plan, entitled the Performance Assessment Project, have been somewhat more successful. MISE staff supported teacher study groups to develop and test performance tasks for classroom use, publishing the most promising tasks and distributing them within the partner districts and beyond. We also supported the work of district personnel to develop or adopt end-of-unit performance assessments for the science modules. This aspect of going to scale is still very much a work in progress. MISE continues to work at developing a comprehensive assessment of inquiry-based science instruction because we recognize the importance of measuring the effects

of science education reform where they count—on student performance. At the same time, we must make sure that the instruments we use accurately reflect the kind of science learning that the project supports.

Current Status of the Reform

The work of the MISE Institute is ongoing. Merck made an initial, ten-year commitment to improving science instruction in the partner districts, beginning in 1993. That commitment has since been renewed through 2008, and we are now establishing a process to develop plans for 5–8 years beyond that. There is no sign from Merck that they are going to back away from this improvement effort.

MISE's work with the partner districts is ongoing, and for the current phase we are using a new strategy to help specify who is doing what, how, and when. We have drawn up a Memorandum of Understanding (MOU), a two-page document specifying commitments to which all partners agree. The MOU is based on what we have learned over the last 12 years about what needs to be in place to support a strong and effective science program. Basically, it specifies "best practice;" i.e., all partners commit to support teaching and learning in science, leverage resources, develop a coherent science curriculum, provide professional development to teachers of science, provide on-site support, enhance student interest in science, and participate in management of the Partnership.

The project now involves seven districts, all located in areas that have Merck facilities. We continue to support the work of the districts, with the districts themselves taking increasingly important leadership roles. We had several meetings with district teams to determine a focus for the new phase of work, and we have picked four major areas to continue and to add new work. The major areas are professional development, instructional leadership for principals and teachers, on-site support (e.g., new teacher mentoring and coaching), and high school science reform.

The fact that we have maintained this work for so many years—and the districts are still eager to be involved and have, in fact, assumed much of the leadership—is a very strong example of a reform project that has "gone to scale."

References

Consortium for Policy Research in Education. (2003). *Systemic reform in practice: Merck institute for science education.* Philadelphia, PA: The Consortium for Policy Research in Education.

Corcoran, T. (2003). *The Merck institute for science education: A successful intermediary for education reform*. Philadelphia, PA: The Consortium for Policy Research in Education.

Fuhrman, S. H., Elmore, R. F., & Massell, D. (1993). School reform in the United States: Putting it into context. In S. L. Jacobsen & R. Berne (Eds.), *Reforming education: The emerging systemic approach* (pp. 3–27). Thousand Oaks, CA: Corwin.

Smith, M. S. & O'Day, J. (1991). Systemic school reform. In S. H. Fuhrman & B. Malen (Eds.), *The politics of curriculum and testing: The 1990 yearbook of the politics of education association* (pp. 233–267). London: Falmer.