

**Three Bridges and Holland Brook
Elementary Schools
Readington Township, NJ**

**A case study about the work of the
Merck Institute for Science Education**

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Biography

Patricia J. Kannapel is an educational consultant specializing in educational research and evaluation. A former public school teacher, Kannapel has conducted educational research since 1990. Recent projects include a 10-year study of the Kentucky Education Reform Act conducted for the Appalachia Educational Laboratory, a 5-year study of professional development in Kentucky conducted for the Partnership for Kentucky Schools, and participation in various research and evaluation projects for the Consortium for Policy Research in Education (CPRE) at the University of Pennsylvania. Kannapel is a doctoral candidate in applied anthropology at the University of Kentucky.

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.

About this Case Study

This case study is one of four written about schools that have been part of MISE's partnership with school districts over the past 10 years. The case studies are intended to present a story about how the reform has impacted science education in classrooms as well as how it has impacted teachers, schools, and districts. The context for each case study is different as each school and district brings its own unique situation and challenges.

The case studies were written as a result of two or three site visits over the past 10 years, visitations of several days which included classroom observations and interviews with teachers, principals, district administrators, and superintendents. Information was also gathered from evaluation reports by CPRE over this 10-year period, beginning with the 1993-1994 school year and ending with the 2000-2001 school year.

Acknowledgments

Each of the four case studies is the product of dedicated research and evaluation by a sole author. It is also important to recognize the contributions of several individuals who worked collaboratively with the author, offering insight and guidance, to produce informative and accurate depictions of the implementation of MISE in each of the four schools. The author would like to thank Deanna Burney, Tom Corcoran, Siobhan McVay, Claire Passantino, and Kate Riordan for their efforts and contributions to this work.

Ordering Information

Copies of this case study are available from CPRE free-of-charge. To obtain copies, email your request to cpre@gse.upenn.edu, phone us at (215) 573-0700, or write to CPRE Publications, Graduate School of Education, University of Pennsylvania, 3440 Market Street, Suite 560, Philadelphia, PA 19104-3325.

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.

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 (LT) — 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 Team — The main purpose of the instructional team members was to teach at 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. Some sessions were for all of the instructional teams together, and there were breakout sessions to allow each instructional team to focus on their specific PTW.

Principal Institutes — MISE offers a Principal Institute to make sure that principals are remaining informed about various aspects of the reform process.

Science Mentor — This position was designated by the district to pilot the new hands-on modules at all grade levels K-5.

Science-by-Mail — In the MISE districts, this is a program where volunteer pen-pal scientists from Merck interact with teachers and students of participating classrooms to provide supplemental hands-on science lessons to be used in their classes. Originally created by the Museum of Science in Boston in 1998, the program is now administered nationwide.

Full Option Science System (FOSS) — Modules specifically selected for each grade level based on careful examination of the New Jersey Core Curriculum Content Standards for Science. The kits are age-appropriate and cover the range of standards as specified by the state.

The Evolution of the Merck Institute for Science Education

Year	Primary Focus	Major Accomplishments
1992-1993	Launching the initiative	Merck & Co., Inc. created the Merck Institute for Science Education (MISE) with a 10-year, \$20-million commitment and the goal of raising student interest, participation, and performance in science.
1993-1994	Building awareness and providing assistance, and setting the groundwork for use of nationally developed curriculum materials	The newly created MISE focused on cultivating relationships with its four partner districts, three in New Jersey and one in Pennsylvania. MISE assisted districts with selection and purchase of new materials for elementary science; and helped local educators envision a new approach to science education by sponsoring their attendance at national conferences, exposing them to state-of-the-art materials and national resources, and encouraging them to visit classrooms with standards-based science instruction. MISE created resource center enabling educators to review and try out new instructional materials.
1994-1995	Taking a more proactive role, evolving into a single Partnership, and designing and implementing the Leader Teacher Institute	MISE focused on improving the quality and accessibility of professional development for teachers. MISE staff assumed a more proactive leadership role and, in the summer of 1995, implemented the Leader Teacher Institute, enrolling more than 140 teachers. This offered a common professional development experience for teams of teachers in the four districts. This helped create a single Partnership – MISE and the four districts.
1995-1996	Increasing resources through a National Science Foundation grant, implementing the Peer Teacher Workshops, continuing the Leader Teacher Institute, and focusing on local policy alignment	MISE received a National Science Foundation Local Systemic Change grant for the purpose of providing 100 hours of high-quality professional development in science and math to 800 K-8 teachers from the four districts over five years. The second year of the Leader Teacher Institute was held. Peer Teacher Workshops were implemented and more than 160 teachers participated in the first summer. As Leader Teacher teams assumed more professional development roles, MISE staff evolved from a supplier of professional development to a facilitator of schoolwide instructional change.
1996-1997	Continuing the Peer Teacher Workshops, completing the Leader Teacher Institute, and focusing on curriculum frameworks and assessment	Two hundred teachers took part in the Peer Teacher Workshops, which were partially led by Leader Teachers. The final year of the Leader Teacher Institute was held. MISE gave more attention to mathematics. The MISE Resource Center was expanded to include material for elementary and middle school math. All four districts completed draft science curriculum frameworks aligned with state and national standards.
1997-1998	Increasing district responsibility for professional development, expanding assessment work, initiating comprehensive planning, and continuing work with Leader Teachers	The Partnership had evolved into a broad collaboration. Peer Teacher Workshops were expanded with 138 teachers participating. Communication and leadership skills of Leader Teachers were expanded to support them as advocates, coaches, and instructors in their schools. MISE staff worked to gain board approval for district curriculum frameworks. Work on improving student achievement measures started.

Year	Primary Focus	Major Accomplishments
1998-1999	Expanding professional development offerings, strategic planning in science, developing a Partnership Assessment Plan, sharing the work of the Partnership, influencing New Jersey policy	MISE increased professional development offerings in the summer of 1999 and helped districts organize and deliver 36 Peer Teacher Workshops, thus building internal district capacity. MISE staff worked with district teams to develop strategic plans that focused on curriculum and instruction, student achievement and participation, policies and practices, and parent and community support. The Partnership adopted an action plan for student assessment in science. MISE staff expanded outreach efforts with new publications that outlined their vision and work. An assessment sampler for teachers was developed. MISE staff provided leadership to statewide boards and committees developing science content standards and professional teaching standards.
1999-2000	Continuing the Peer Teacher Workshops, expanding and focusing the work in the middle schools, implementing the Partnership's assessment plan	MISE and the districts offered 31 Peer Teacher Workshops in science and math in the summer of 2000, held in district locations to increase participation. MISE staff expanded and strengthened work in middle schools. Teams of teachers and MISE staff selected, modified, and tested two TIMSS (Third International Mathematics and Science Study) tasks for third and seventh grades.
2000-2001	Expanding the district role in the design and delivery of the Peer Teacher Workshops, implementing the Principal's Institute, working on site in three middle schools, and working on the Performance Assessment project	MISE continued to offer Peer Teacher Workshops. A two-day institute for school principals was held to increase their understanding of high-quality science instruction and their capacity to help teachers provide it. MISE staff continued to work on the development of curriculum frameworks and the selection of instructional materials for the middle grade level. The Partnership Performance Assessment project was replicated in all grade 3 and 7 classrooms.
2001-2002	Continuing the enhancement of local district responsibilities for Peer Teacher Workshops, implementing the Principal's Institute, working on site in three middle schools, initiating work at one partner high school, and enhancing the Performance Assessment project	Peer Teacher Workshops reflected the needs of a context where there is a high level of district commitment to standards-based science. A two-day conference continued the institute for principals to focus on their roles in encouraging good science teaching through teacher observations. MISE staff worked with district committees to establish formal curriculum frameworks for school board adoption. Science reform work was initiated at one partner high school using the selection of instructional materials as the reform focus. The Partnership Performance Assessment project was expanded with tasks administered at grades 3, 7, and 8.
2002-2003	Continuing Peer Teacher Workshops, continuing the Principal's Institute, working on site with middle schools, implementing science reform work at one partner high school, and initiating district-level assessments for science modules	Peer Teacher Workshops responded to the needs of districts committed to standards-based science. A second conference for principals focused on the power of professional dialogue about instruction. Science reform work continued at one partner high school using the selection of instructional materials as the reform focus. Two partner districts cooperated to develop, administer, and interpret summative assessments aligned with instructional modules.

Introduction

The Readington Township School District in New Jersey is an unusual public school district in many respects. Once a rural area (or as one teacher phrased it, a “cow path”), the district has become increasingly suburban as corporate offices and new housing developments have attracted upper-middle-class residents to the area. Among the “neighbor” corporations is Merck — a corporation that has influenced Readington schools much more directly than simply bringing in well-educated, upwardly mobile residents.

Merck began its involvement with Readington Township schools by donating computers for the district’s first computer lab. Then in the spring of 1993, the Merck Institute for Science Education (MISE) established an official partnership with the Readington School District. Since that time, the MISE Partnership has been instrumental in changing the way science is taught in Readington schools. This case study describes this transformation and how it came about in two of Readington’s three elementary schools: Three Bridges School and Holland Brook School.

The Schools

The success of the MISE Partnership at Three Bridges and Holland Brook Schools rests in no small way on the character of the schools themselves, including several key factors that contributed to this success: district and community support, characteristics of students and parents, district and school leadership, and the strong professional community within the schools. This section sets the context for the remainder of the case study by describing those factors.

When the MISE Partnership was formed in 1993, Three Bridges was one of two K-4 elementary schools in Readington (the other was Whitehouse School). The two acted as feeder schools for Readington Middle School, serving grades 5-8. Because Readington Township does not have its own high school, students are sent to Hunterdon Central Regional High School, located 10 miles away. As district enrollment increased, the Readington School District constructed and opened a third elementary school in 1999, Holland Brook School, to serve students in grades 3-5, and converted Three Bridges and Whitehouse to K-2 schools. District enrollment has continued to grow from 1,500 students in 1994, to 2,200 students in 2002. One consequence is that Holland Brook, built to serve 700 students, is already bursting at the seams with 770 students.

Readington students are primarily White and come from middle- and upper-middle-class families; less than 7% of students are minorities, and only 2% are eligible for free or reduced-price lunch. Readington parents are largely supportive of and involved in the schools and vocal about programs that affect their children. Local support for the schools is evident in the district’s finances. As a consequence of the community’s wealth, about 90% of Readington’s school revenues come from local sources, compared to a state average of about 68%. This fact was noted with some pride in the April 2002 school district newsletter: “We are not a high-spending district, but 90% of our revenues are paid by the local taxpayers; the state and federal governments provide us with very little funding” (Readington Township Public Schools, n.d.). The district also pays substantially higher salaries to administrators than state averages.

Students in the Readington School District perform well on nearly all measures. Readington schools are above the state average in student attendance rates, and below the state average for student mobility and student suspensions. Students score consistently above state and national averages on standardized and state assessments.

Reforms began in the Readington School District following the hiring of Superintendent Thomas Gannon in 1989. Until that time, a superintendent in place for 30 years had maintained a traditional approach to education. The arrival of Superintendent Gannon coincided with national interest in school restructuring and a shift from traditional, skills-based instruction to a focus on developing students' critical thinking and problem-solving abilities, and connecting instruction with real-life situations. Dr. Gannon promoted these kinds of changes, which coincided nicely with the MISE Partnership. There have been several superintendents since Dr. Gannon's departure, but each one has kept the district moving in the direction set forth by Dr. Gannon.

At Three Bridges School, Principal Pat Ryan is the sole administrator of 330 students, 16 homeroom teachers, and 4 special education or early intervention teachers. The teaching faculty has been stable; many teachers have taught at the school their entire teaching careers.

At Holland Brook School, Principal Joan Oley and Assistant Principal Angela Deeney lead this school of 770 students, 35 homeroom teachers, 12 special education teachers, and a number of specialists. Many of Holland Brook's teachers are new, owing to the newness of the school itself, but a number of teachers transferred from Three Bridges, Whitehouse, or Readington Middle School when students from those schools were transferred to Holland Brook.

A veteran teacher at Three Bridges and Holland Brook describes the teamwork, camaraderie, and administrative support:

Here it is all about the team. One thing our administration does here, they promote teamwork...I come to school every day loving my job and I come to it with a smile...It is a great place to work.

Professional community is fostered at the two schools through weekly common planning time for grade-level teams held during the school day. At these meetings, teachers discuss issues of importance including science. In addition, students are dismissed early once a month for half-day, district-wide curriculum meetings, so that Three Bridges and Whitehouse teachers can share ideas and develop consistent practices in science, as well as other content areas.

Administrators at each school are described by teachers as positive, supportive, and well-informed about what is happening in their buildings. Three Bridges Principal Pat Ryan visits classrooms at least bi-weekly to check lesson plans and stay abreast of what is happening. She also collects end-of-unit assessment results in science and social studies to keep informed of student progress. New teachers at Holland Brook reported in October 2002 that either Principal Joan Oley or Assistant Principal Angela Deeney had been in their rooms three or four times already that year, and that both administrators are highly visible in the school. They also noted that administrators are very responsive to teacher needs:

This school has a team approach because we have that weekly common planning and we have the time to plan and coordinate and share ideas. This is an upbeat and positive school...the principal is very supportive. She is the one who got me involved in the new teacher training. She

likes to collect the assessments for the whole class at the end of the unit.

Parents of Three Bridges and Holland Brook students are highly involved in the schools through the Home-School Associations and Family School Councils. Parent volunteers have been used in science lessons from the outset of the MISE Partnership. Three Bridges has sponsored a Family Science Night for the past several years. Many more parents want to participate than can be accommodated, so teachers select one family from each first- and second-grade class to participate, for a total of 30-40 participants. Holland Brook recently hosted a science festival in which community volunteers, including several scientists, did presentations and hands-on activities with students.

Science Instruction — Then and Now

Science education in Readington has changed dramatically over the past 10 years. Prior to the district's involvement with MISE, the science program at Three Bridges was, with a few exceptions, centered around the 1982 Scott Foresman science textbook series. Science instruction in most classrooms emphasized recall of facts, rules, and laws. Science was often worked in when teachers found time. No systematic assessment of individual students' science learning was taking place.

The current science program at Three Bridges and Holland Brook bears little resemblance to the program just described. Science is now experienced by Three Bridges and Holland Brook students as investigative, exploratory, hands-on, and engaging. Instead of textbooks, science instruction is based on a science curriculum framework developed in 1998 as part of the MISE Partnership. The framework is inquiry-based,

and is taught primarily through district-adopted commercial science kits that closely match the framework. The kits were selected with assistance from MISE. (Appendix A contains a list of the science modules adopted by the district.) Students now learn about science concepts such as magnets, weather, seeds and plants, electricity, and ecosystems through scientific investigation.

Initially, teachers struggled with the shift from a textbook to a hands-on approach, and many teachers continued to use the traditional approach for the first two-to-three years. Now, however, hands-on science instruction is the norm at Three Bridges and Holland Brook, and most teachers favor the hands-on, real-life approach to science instruction. A first-year teacher says:

My kids are coming every day asking if it is science day, so it has to be active for them. There is not much reading of information. They are recording or building; we are doing terrariums right now. They just built their terrariums. They did it in groups, drawing on each other. They were given little instruction by me...They run in each morning to see what is in there and want to add.

Administrators, teachers, parents, and students at Three Bridges and Holland Brook support the hands-on, inquiry-based approach to science instruction. They believe students are more engaged with science, and are learning at a deeper conceptual level than previously. Holland Brook Principal Joan Oley says this is especially true for special education students:

There is more of a comfort level for special-needs students, because of our approach, in how they discover in the inquiry process...Sometimes you have a special education kid who gets turned on about science.

A second-grade teacher describes her students' level of engagement:

They are doing more talking among themselves, trying to explain to each other. It is not just learning of black-and-white facts; they see it happening, they understand it better...The kids are asking questions of me that they never would have asked before.

A veteran fourth-grade teacher, who advocates a mix of inquiry-based and traditional approaches, describes the deeper kinds of learning students experience with the inquiry-based approach:

Kids have to come up with more of their own decisions about things, they have to draw conclusions about things more. The textbooks aren't there to tell them the answer. They have to come up with the answer, and that is important...The kids now don't memorize; they now are actually learning from the experiments that you are doing.

Parents also support the current approach to science:

I like the fourth-grade unit where they wire the house in electricity. In third grade, they did crayfish in the classroom and saw all the biological systems; they followed a pregnant one and learned about why some died. In fifth grade, they are looking at an ecosystem with terrariums, live creatures, etc. The fourth grade just went on the river trip; they now go in the fall and spring. I have seen science journals where they have to log things. I like the way they teach science.

The kids enjoyed the magnets. The butterfly [unit] was the best science class that she had. When they released the butterflies, I enjoyed it as a parent — just watching the kids observe these butterflies from start to finish.

Assessment

Now that science instruction is more hands-on and connected to real-world science, teachers also are changing how they measure what students are learning. In partnership with MISE, Readington teachers have been working for six-to-seven years on developing science assessments that are more performance-based. Teachers at Three Bridges and Holland Brook use pre- and post-tests for each curriculum module developed by Readington teachers during MISE summer institutes. The assessments are a combination of paper-and-pencil tasks and performance tasks. In one fourth-grade classroom, the students explained that the skeletons hanging around the room, constructed from plastic milk jugs, were used to test what they had learned at the end of a science unit.

A look inside a kindergarten classroom provides another example of the new kind of science assessment. In this classroom, the teacher did an earlier pre-test on aquarium life in which teams of students drew pictures on poster paper of what they thought might be in an aquarium. Today, the students are doing a post-test in which the same teams draw a picture of an aquarium on the other side of their pre-test drawing:

The students are scattered about the workspace area of the room seated at six tables. There are three or four students at each table. While the teams are busy drawing their aquarium, one boy comes up to the teacher with a question and she responds: "I'm not part of your group. I can't help you." She directs him back to his team for help. As teams finish, the teacher asks the first group to describe what they added to their aquariums. The first student says, "A filter." The teacher asks why and students respond, "To keep the water clean." The next student says they added a jellyfish. With a puzzled look, the teacher says that should have

been discussed with the group (jellyfish are only in saltwater). Another student says they added plants. The teacher asks why, and the whole class gets into a discussion about how the fish can eat plants or hide in them. Another member of the team says they added fish and the teacher questions her about what kinds of fish. The last person volunteers that they added a heater to keep the temperature more even. In the next group, students talk about adding gravel as a way to keep the water clean and germ-free. There is a discussion of the need for a filter, as one student remembers an experiment the class did using filters with different-sized holes. Students recall that some of the filters performed better than others.

A fourth-grade teacher describes the assessment of the Weather unit:

“Describe the difference between climate and weather,” and they write the response. They show a thermometer and they identify it and name two things that it does. Another is, “If the weather is this on Tuesday, what was the weather on Thursday according to the weather map?” “Describe the climate of New Jersey.” “What do certain symbols mean?” That one was mostly pencil and paper. The hands-on would be something like, “Demonstrate your knowledge of evaporation in this dish versus this tube. Which one do you think would evaporate first?”

Since the spring of 2000, third graders at Holland Brook have participated in a Partnership-wide performance assessment using performance tasks drawn from TIMSS (the Third International Mathematics and Science Study). Teachers administered a task using magnets to all children in the third grade. The results of this assessment have been used by teachers at Holland Brook to improve their instruction.

Making Change Happen

Clearly, the science program at Three Bridges and Holland Brook has undergone a radical transformation over the past 10 years. How did this happen? What forces combined to bring about such a major change?

In the Readington School District, the partnership with MISE was absolutely instrumental in creating the impetus for change, keeping the district focused, providing direction, and maintaining stability over a period of years. Note the use of the word “partnership” here — MISE alone could not have accomplished nearly so much without the commitment of district leaders and it is unlikely the latter could have done it without the expertise and resources of MISE. It was the stable partnership among MISE, district and school administrators, and teachers that facilitated the transformation of science education in the district. This occurred even though there were changes in the central administration during the 10-year period. A brief history of the partnership is illustrative.

The initial impetus for change in the Readington School District was provided by former Superintendent Thomas Gannon. He supported innovative approaches to science and other subjects. Subsequent superintendents continued the effort. Joan Matula, former Director of Curriculum and now Assistant Superintendent, has helped maintain the focus on inquiry-based science. Entering into the partnership with MISE gave the district the resources and guidance it needed to transform its science program.

A number of activities and strategies over the years — nearly all of them done in partnership with MISE — have moved the district vision forward. One of Dr. Gannon’s first steps was to employ a district science supervisor, responsible for teaching two classes per day at the

middle school, ordering science materials for the schools, and making program improvements to the K-8 science program. Since that time, the Readington School District has intermittently employed science resource teachers to assist in the move to an inquiry-based approach. For instance, in 1993-1994, an elementary science resource teacher traveled between Three Bridges and Whitehouse schools, providing weekly science labs for over 800 K-4 students. The following year, two elementary science resource teachers were hired so that each school had one full-time science resource teacher. At the same time, the K-8 science supervisor position was eliminated. Since Holland Brook School opened in 1999, two science resource teachers have worked with Holland Brook students and are on call for Three Bridges and Whitehouse teachers.

Professional Development

Even more powerful than these support systems, however, has been the professional development provided to teachers through the MISE Partnership. This began in the summer of 1993 when a team of Readington administrators and teachers attended, courtesy of a MISE grant, the summer science institute at the National Science Resources Center located at the Smithsonian Institution. Participation in this institute provided a direction for transforming the science program as the district made its first attempt to move from a textbook-based approach to the use of hands-on kits. This switch was rocky at first due to lack of teacher input into kit selection and inadequate training for using the kits.

Recognizing that a more powerful professional development strategy was needed, MISE launched the Leader Teacher Institute (LTI) in 1995 to provide intensive professional development to a select group of teachers from each partner school over a three-year period. The

Leader Teachers would become well-versed in the pedagogy of inquiry-based science and pertinent content within the three main strands of science: earth, life, and physical. These Leader Teachers were then expected to become science leaders at their schools. Readington Township sent 14 teachers to the LTI, 5 each from Three Bridges and Whitehouse and 4 from Readington Middle School.

Three of the original 14 Leader Teachers still on staff at Three Bridges and Holland Brook in 2002 report that their participation in the LTI greatly increased their enthusiasm, content knowledge, and sense of professionalism. In addition, they used their expertise to provide information, lead discussions, and present professional development to other teachers in their schools or districts. A former Leader Teacher comments:

We encouraged everyone to get involved in summer workshops. People liked what was happening and it helped us organize and talk through a unit. People would say that there was enthusiasm and excitement here over science.

While those who participated in the LTI reported great professional benefits for themselves, the strategy was not as effective in spreading science expertise to all teachers in the partner schools, for a variety of reasons. A few of the original Leader Teachers were not able to continue for the full three years, and some were more effective than others in sharing what they learned. But perhaps more importantly, Leader Teachers found it difficult to replicate in their own buildings the intensity of excitement and learning that they experienced first-hand in the summer institutes.

In 1996, MISE worked with its partner districts to launch a series of professional development opportunities open to all K-8 teachers in an effort to engage more teachers in science reform. These Peer

Teacher Workshops (PTWs) were open for voluntary enrollment, and each one was led by a team consisting of a combination of Leader Teachers, content specialists, instructional specialists, and classroom teachers. Each subsequent summer, a series of week-long PTWs has been offered to teachers in the partner districts. The peer workshops focus on the science curriculum modules adopted by the districts. Teachers explore the modules, observe demonstration lessons, develop assessments, and share ideas.

The peer workshops built expertise among *all* teachers in the partner schools. Teachers at both Three Bridges and Holland Brook have taken great advantage of the PTWs. New hires at each school are told about the workshops when they are hired and urged to attend; nearly all of them do so. In addition, most veteran teachers attend the summer workshops annually to update their skills, help revise assessments, and align science modules with district and state standards. Teachers describe the usefulness of the summer workshops:

I attend all of the summer Merck training. There are four days in the summer, and then we meet twice during the school year. We get to work with the kindergarten teachers from Whitehouse School, and it gives us a chance to really concentrate on science... Sometimes we focus on a specific unit; last year we worked on integrating science and language arts. This past year, we came up with some assessments we would use in our units.

A second-grade teacher with over 25 years of experience describes how the summer workshops have evolved to meet current needs:

The Merck professional development sessions have changed. They started out with Merck directing it and now our people direct it. It was great when it started out because they showed us how to

get our kids inquiring and thinking. Then when our people took over, we looked at areas where we felt we needed to revamp the science curriculum. Our people can put it on the second-grade level, whereas the Merck scientists tended to be thinking more on a high school level and we had to figure out how to adapt. Merck started us out at a higher level of thinking, which was good.

As these comments indicate, summer science training in partnership with MISE has not only helped teachers learn to teach science through hands-on, inquiry-based activities, but helped them develop the current curriculum and design assessments to go along with it.

Beginning in about 1996, MISE began to work with the partner districts to develop science curriculum frameworks aligned with state and national standards and supported by the new instructional materials. All districts completed drafts of science curriculum frameworks by 1996-1997. The following year, MISE staff worked with district staff to gain board approval for district frameworks.

The Readington science curriculum framework, available on the district website, was developed by Dr. Joan Matula, science resource teachers, and teachers from district schools. The district vision for science is inquiry-based, as described in the science curriculum framework: "The Readington Township science program is based on the belief that all children are innately inquisitive and creative in examining the world around them" (Readington Township Public Schools, n.d.). The framework describes the broad concepts that will be covered at each grade level, as well as the proficiencies students should demonstrate at the end of the year, assessment methods for recording progress, and technology applications. The framework defines the concepts to be taught, while the science kits adopted by the district

provide the structure for teaching those concepts, as explained by teachers:

We decide as a grade level what we will use from kits and what we will not. If we run out of time, we have to do at least what our goals say we have to do in science. You have to match the kits to what the goals are.

Teachers and administrators at Three Bridges and Holland Brook agree that science education is now a high priority in their schools and the district. Science is a regular part of the curriculum — not just something teachers do if they have time. Various teachers remarked:

Science is a very high priority for the district and this school, which is why I wanted to come here.

Readington does better science teaching than I have ever seen.

Most people at Three Bridges and Holland Brook schools give strong credit to the MISE Partnership for getting the science program where it is today. Three Bridges principal Pat Ryan provides this perspective on what has driven science education over the past 10 years:

Persistence on everyone's part. Persistence on the part of teaching staff to be excellent... That is a norm in this group. Then you have an administrator who has that same philosophy, and a board who supports that as well. Then Merck has been a tremendous influence. If any one piece was removed from the mix, we would not be where we are now. The person put in place for Director of Curriculum and Instruction is the ever-present constant voice who keeps us focused. If I had to hang my hat on that one thing, it is that constant reminder that is Dr. Matula.

Teachers place an even stronger emphasis on the role played by MISE in

transforming the science program in Readington:

Involvement with Merck is the major influence in where we are now. That helped provide resources and training and the tools necessary to move forward.

Merck probably drove most of it — pushing us toward investigative learning as opposed to content-rich information dumping.

Effects of the MISE Partnership and Changes in Science

The effects of the MISE Partnership and of the transformed science program extend beyond changes in instructional style for teaching science. As a result of the Partnership, district scores on state science tests are quite high, classroom science instruction is more closely connected to real-world science and involves students in hands-on scientific investigations, students are more engaged with science and their teachers believe they are learning at a deeper conceptual level, and parents are pleased with the science program.

There have also been other effects of the Partnership that were, perhaps, unanticipated. Teachers and administrators at Three Bridges and Holland Brook report that changes in the science program were only the first step toward innovation in the district. Three Bridges Principal Pat Ryan comments, “You can’t have your mind opened and not have it spill over.” Teachers make similar remarks. Clearly many have begun looking at how the changes they have adopted in science education can influence other aspects of their teaching practice:

The training that I had [in science] transferred to every subject. I used to be more opinionated about things and now I

am more open. You let the kids lead the class more so than what I used to do; that was the biggest shift for me.

I think that science pushed some of these other programs to change. Our system has been investigating programs that have more hands-on and thinking in math and social studies. We have been doing it with science longer than in the other subject areas. We are working to meet standards and that is part of it, but science was the first one and maybe it is because we were connected with Merck that we started doing more.

Involvement with MISE has also increased collaboration among teachers and schools, and contributed to a focus on professional development, as described by teachers:

These new school structures lend a new dimension to the support system. Bringing all third-grade teachers together to work on science was a new idea. Then we replicated that idea.

The Merck project forced us to get together. Before it was K-4 schools and a middle school building. Once we were forced to be together [at MISE workshops], we saw how much we could accomplish. Now there are curriculum days once a month. We now have the Continuing Education topics for professional development... Yes, definitely I think MISE had a part in this. They set a great foundation.

The district's strong emphasis on science influenced hiring practices as well. Prospective teachers are asked about their science background and teaching philosophy during interviews. In hiring teachers for Holland Brook, Principal Joan Oley looked for applicants with a strong science background. She ended up hiring two teachers who had prior experience working in area science centers — one at an aquarium and an-

other at a nature center. Teachers new to the district in 2002 shared these comments:

When I interviewed for this job, they specifically asked about my science background, as well as in other subjects. I was also encouraged to attend science institutes.

They asked me a lot [during the interview] about inquiry-based... They asked how I would teach a lesson. Then I had to do a demonstration lesson. They were studying the desert, so I did a hands-on activity on cactus.

Impact Beyond Science

MISE's influence goes beyond science. The MISE approaches to professional development and collaboration were adopted by the district and have become part of the district culture. In addition, the move to hands-on, inquiry-based science instruction paved the way for the use of similar techniques in other subjects.

The lessons learned from the MISE Partnership with the Readington schools are about the conditions that enable a corporate partner to have a strong impact. Some of these conditions were under the control of MISE, some in the hands of the school district. The factors that most contributed to the success of the Partnership were:

- **The long-term nature of the Partnership.** MISE worked with the partner districts collaboratively for 10 years toward the common goal of making the science program the best it could be.
- **Resources.** MISE funding helped the district purchase the science modules, offer intensive professional development, and do other things it otherwise could not have afforded.

- **District commitment.** The Readington Township School District made a long-term commitment to working with MISE and providing the support to improve the district's science program.
- **Responsiveness to feedback and research.** MISE and district administrators tried numerous strategies over the years for building science expertise and paid close attention to feedback and research on what was working well and what was not. This responsiveness led, for example, to the expansion of LTIs (for a select few) into PTWs (open to all teachers).
- **Quality professional development available to all.** Teachers cannot say enough about the high-quality professional development they received at PTWs. The fact that these workshops are open to all teachers, and attended by most, was critical in spreading science expertise throughout the two schools.
- **Strong content focus.** Teachers appreciated the use of scientists in the MISE institutes and believe their own content knowledge has been greatly enhanced by the training they received from MISE science "experts."

When asked how the MISE Partnership might have been improved, teachers and administrators at Three Bridges and Holland Brook were hard-pressed for a response. Some teachers believe more attention should be focused on how to integrate science with other subjects. Administrators would like to see classroom instruction be less teacher-directed. Others hope to maintain contact with professional scientists. These suggestions offer a direction for continued work in Readington on improving the science program.

The experience in Readington demonstrates how outside partners can help transform what happens in schools. MISE proved itself a responsible and caring neighbor and partner by using its expertise in the area of science to work with the schools in a truly collaborative way to make science education more like real-life science. Some Readington educators fear that moving to the next phase of the MISE Partnership will lead to complacency or reduced ability to build and maintain capacity. It is clear, however, that a culture has been created which is practiced and supported by nearly all district players — administrators, teachers, parents, and students. This kind of culture will not easily disappear.

Lessons Learned

The impact of the MISE Partnership on the Readington Township Schools has been positive. Science, once perceived as a set of facts to be presented and memorized as time permitted, is now thought of as a process of inquiry and discovery that is an integral part of the curriculum. Throughout their schooling, Readington students discover, through hands-on experiences, information about such things as the life cycle of a butterfly, river ecosystems, phases of the moon, electricity, chemistry, oceans, seeds, and plants.

The MISE Partnership has become part of the school district's identity. In fact, information on the MISE Partnership is featured on the district's website:

For the past nine years, we have been involved with Merck in a business-school partnership which has brought a richness of resources to our district. Many of our teachers have received training for teaching inquiry-based science which encourages our students to engage in higher-level thinking and problem-solving (Readington Township Public Schools, n.d.).

A new teacher to the school district tells of the strong connection with Merck that was evident during his interview process:

When I interviewed, every person I spoke to mentioned Merck. The Partnership came up and then once I came to the first summer training, I started to understand the extent of the involvement. Merck is an active player here.

Teachers and administrators cannot say enough about what the MISE Partnership has done for their schools. Three Bridges Principal Pat Ryan believes the district would still be using textbooks in the absence of the MISE Partnership and credits the program for helping her recruit new teachers:

The summer training is a boon to bring in new teachers and keep others up-to-date. I am concerned where we will get this level of training again. This was basically in our backyard. We built our curriculum around what Merck did for us.

Holland Brook Principal Joan Oley is equally effusive:

It was an extraordinary opportunity for this district, very rewarding. Merck has been right on the cutting edge with math and science. They have given us so many opportunities...With continued support from Merck and with the teachers we have been hiring, we are really [raising] that level of inquiry-based science.

The transformation of science education in Readington was accomplished through a professional development and support structure that brought scientists, administrators, and teachers together regularly over a 10-year period to learn new content, deepen understanding of science concepts, and observe and practice ways of helping students learn about these concepts. The expansion of LTIs into PTWs was instrumental in spreading science expertise to all classrooms.

The school district was a key player in fostering and supporting these changes. The stable presence of MISE kept the science initiative going through administrative changes, while the district's unfailing support for the initiative and willingness to adopt MISE's professional development and collaborative structure were keys to the success of the Partnership. A district ethic has been established in which teachers coming into the district recognize the importance of inquiry-based science, and in which veteran teachers understand that they must continue to develop their own science knowledge, understanding, and pedagogical skills.

References

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Appendix A. Usage of Science Modules in Partnership Districts

Grade	Linden	North Penn	Rahway	Readington
K	Senses (Insights) Balls and Ramps (Insights) Animals 2x2 (FOSS) Paper (FOSS)	Senses (Insights) Living Things (Insights) Paper (FOSS)	Animals 2x2 (FOSS) Paper (FOSS) Balls and Ramps (Insights) Senses (Insights)	Senses (Insights) Paper (FOSS) Animals 2x2 (FOSS)
1	New Plants (FOSS) Balance and Motion (FOSS) Insects (FOSS) Weather (STC)	Weather (STC) The Life Cycle of Butterflies (STC) Solids and Liquids (STC)	Solids and Liquids (FOSS) Air and Weather (FOSS) New Plants (FOSS) Balance and Motion (FOSS)	Weather (STC) Balls and Ramps (Insights) From Seed to Plant (DSM)
2	Solids and Liquids (FOSS) The Life Cycle of Butterflies (STC) Balancing and Weighing (STC) Soils (STC)	Organisms (STC) Balancing and Weighing (STC) Soils (STC) Changes (STC)	Pebbles, Sand, and Silt (FOSS) Insects (FOSS) Balancing and Weighing (STC) Investigating Objects in the Sky (BSCS)	Soils (STC) The Life Cycle of Butterflies (STC) Solids and Liquids (FOSS)
3	Structures of Life (FOSS) Magnetism and Electricity (FOSS) Earth Materials (FOSS) Investigating Objects in the Sky (BSCS)	Electric Circuits (STC) Chemical Tests (STC) Animal Studies (STC) Water (FOSS)	Magnetism and Electricity (FOSS) Human Body (FOSS) Water (FOSS)	Structures of Life (FOSS) Physics of Sound (FOSS) Earth Materials (FOSS) Balance and Motion (STC)
4	Human Body (FOSS) Physics of Sound (FOSS) Land and Water (STC) Investigating Ecosystems (BSCS)	Plant Growth and Development (STC) Rocks and Minerals (STC) Land and Water (STC) Designing Structures (BSCS)	Earth Materials (FOSS) Structures of Life (FOSS) Physics of Sound (FOSS) Investigating Ecosystems (BSCS)	Electric Circuits (STC) Land and Water (STC) Levers and Pulleys (FOSS) Human Body (FOSS) Water (FOSS)
5	Environments (FOSS) Mixtures and Solutions (FOSS) Solar Energy (FOSS) Motion and Design (STC)	Microworlds (STC) Ecosystems (STC) Motion and Design (STC) Investigating Weather Systems (BSCS)	Mixtures and Solutions (FOSS) Environments (FOSS) Motion and Design (STC)	Magnets and Motors (STC) Mixtures and Solutions (FOSS) Environments (FOSS) Food and Nutrition (FOSS) Oceans (DSM)
6	Diversity of Life (FOSS) Weather and Water (FOSS) Mirrors/Color Analyzers/Refraction (Boston Science Museum/GEMS/local)	Magnets and Motors (STC) Measuring Time (STC) Solar Energy (FOSS) Light and Color (Project Aries)	Diversity of Life (FOSS) Weather and Water (FOSS) Mirrors/Color Analyzers/Refraction (Boston Science Museum/GEMS/local)	Experiments w/ Plants (STC) Planetary Science (FOSS)
7	Populations and Ecosystems (FOSS) Planetary Science (FOSS) Energy, Machines, and Motion (STC)		Populations and Ecosystems (FOSS) Planetary Science (FOSS) Energy, Machines, and Motion (STC)	
8	Environmental Issues (local) Earth History (FOSS) Properties of Matter (STC)		Environmental Issues (local) Earth History (FOSS) Properties of Matter (STC)	

FOSS = Full Option Science System

STC = Science and Technology for Children

BSCS = Biology Sciences Curriculum Study

Insights = Insights: Inquiry-based Elementary School Science Curriculum

GEMS = Great Explorations in Math and Science

Project Aries = Astronomy Resources for Inter-curricular Elementary Science

DSM = Delta Science Modules