The Merck Institute for Science Education

# Explorer

Volume I Spring 1999

## The MISE Mission: To Improve All Students' Understanding of Science

In a special education classroom north of Philadelphia, students with communication disorders are using the process of scientific inquiry to unravel the mysteries of liquids and solids, plant and animal life, and meteorological phenomena.

Margo Bartiromo and her 4th grade students examine a crayfish at the Madison School in Rahway, New Jersey.

In elementary classrooms in a New Jersey community, an African American chemical engineer employed by Merck & Co., Inc. is volunteering her time to help students learn about the growth cycle of plants. She also hopes to demonstrate by example that the field of science is not only interesting, but that it welcomes the participation of all talented individuals.

And in workshops at sites in New Jersey and Pennsylvania, teachers are learning how to make science topics interesting and challenging to students of all races and backgrounds.

The Merck Institute for Science Education (MISE) is guiding and sponsoring these and other efforts to fulfill an important mission: to improve science teaching so that all children have access to a high-quality science education.

"This mission has been the driving force behind the Merck Institute since its inception six years ago," says MISE Director Carlo Parravano, Ph.D. "To highlight the pressing need for deeper science understanding and greater inclusiveness, the premier issue of this newsletter is focusing on the theme 'Science for All.'"

Providing a challenging and interesting science curriculum for all students sounds like a reasonable goal, but for most of this century it has been standard practice to deny some children the opportunity to study rigorous material in science, math and

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### Highlights

***Science for All* Issue**

## MISE Committed to Science for All

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other subjects. Most of our schooling has been premised on the notion that students either had the gift of innate intelligence or they didn't, rather than the belief that children can "learn to be smart."

*MISE believes that all children must have access to a high-quality science education.*

A new paradigm, which supports the Science for All theme of this newsletter, assumes instead that all children, regardless of their social circumstances, have the innate ability to learn. In this view, teachers share the belief that all students have the capacity to function at high levels if they are given expert instruction.

Further, the assumption that children can develop the necessary skills to perform well in challenging subjects such as science is a prerequisite to the standards movement. It makes no sense to require high academic standards if it is not also assumed that all students have the intellectual capacity to achieve them. In addition, it makes no sense to engage teachers in professional development that enables them to teach more effectively if the system already has determined that some students are unable to grasp the material, no matter how it is presented.

"MISE believes that effective professional development for teachers must be built on the premise that all children have the capacity to achieve at high levels," says Susan Elko, MISE's manager of professional development programs. It is up to teachers to make the learning challenging and relevant. It is up to the state and the school districts to provide the necessary leadership and support—in the form of educational policy and classroom materials—to enrich science learning. And it is up to parents and the community to expect and support high standards in education.

To work toward the goal of Science for All, MISE has developed an action plan that includes the following components:

- **Professional development.** MISE leads professional development programs for teachers from partner public school districts to help them improve their knowledge and teaching skills so that science is challenging and relevant to their students. Carole Stearns, Ph.D., manager of MISE's education programs, says: "The idea is to get teachers to see science as arising out of students' immediate experiences and building on them, rather than viewing science as a well-designed product that is the same for all of us."
- **Curriculum reform.** MISE works with local school districts to select curriculum materials that encourage inquiry and exploration, and it has established science materials resource centers in New Jersey and Pennsylvania to help teachers expand their teaching repertoire. To achieve the same goals nationally, MISE recently underwrote and guided the development of a resource guide for middle school teachers.
- **Parent and community support.** MISE relies on critical support from parents and the community to improve children's science and math learning at school and to extend these investigations at home.

These pages offer examples of what MISE means by Science for All. We hope that readers will use this information to guide their own work in science education. ◂

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# Teachers Hold the Key to Better Learning

**By Carlo Parravano, Ph.D.**

In their efforts to ensure that more children succeed in school, educators and others have advocated higher standards, a longer school year, computers in the classroom, improved curriculum materials and other measures.

Certainly all of these things can make a difference—and the Merck Institute for Science Education uses a number of them in pursuing its mission to provide high-quality science education to all students. But given limited resources, where should most of the effort be concentrated? What will make the greatest difference to students in the classroom?

We believe that teachers are the critical factor. Since its inception, the Merck Institute has focused much of its resources on the professional development of teachers because we believe that good teachers—those who have both excellent content knowledge and teaching skills—can have a profound impact on student learning.

Recent research provides evidence that the quality of teaching does, indeed, make a big difference, particularly for minorities and for children of poverty. The Education Trust, a non-profit organization in Washington, D.C., reviewed the literature and found several large-scale studies that document the case.

In Tennessee, for example, researchers found that low-achieving students who had the least effective teachers achieved gains about one-third as great as low-achieving students who had the most effective teachers. The impact of teacher effectiveness was significant for middle- and high-achieving students as well. Studies in Dallas and Boston produced similar results. And in some cases students' scores on achievement tests actually dropped or showed no growth after the students were taught by three consecutive teachers considered to be least effective.

The studies suggest that over several years, the cumulative effect of good or bad teachers can determine whether students who start out at about the same ability level end up in a remedial track or in classes for the "gifted."

One of the more troubling conclusions reached by other cited studies is that poor and minority students are most likely to be assigned to the least effective teachers. In many instances, these are children who for various reasons already are entering schools with a deficit. Common sense would dictate that these children be assigned to more effective, not less effective, teachers.

Altogether, these findings confirm what we have long suspected—that teachers play a major role in determining a child's success in school, eventual economic future and overall quality of life.

So it is with good reason that the Merck Institute invests in such programs as the Leader Teacher Institute and Peer Teacher Workshops. These programs not only provide teachers with the science content and teaching skills they need to engage a diverse student population, but they also encourage teachers to share their learning with colleagues, thereby increasing the likelihood of excellent classroom teaching.

MISE does not subscribe to the common assumption that some students can't handle the demands of a rigorous curriculum. Rather, MISE assumes that all students can achieve at higher levels if we provide them with high-quality instruction and curriculum materials, set within the context of high standards for all students.

Clearly, the greatest gains will come about when all of the factors that contribute to educational achievement are in place and working in concert. Until we achieve that ideal state, however, it makes sense to pay particular attention to the people we entrust with the education of our children—our teachers. ◂

# Science Instruction Makes a Difference for Special Education Students at Gwynedd Square Elementary

Anyone who doubts the feasibility of "science for all" would probably do well to visit Jack Fink's speech and language support classroom at Gwynedd Square Elementary School in Montgomery County north of Philadelphia. There a visitor is likely to find kindergartners and 1st graders engrossed in studying the properties of solids and liquids or building a terrarium. These are children who, just a few years ago, would have had little or no opportunity to tackle science topics because it was assumed they weren't capable of such learning.

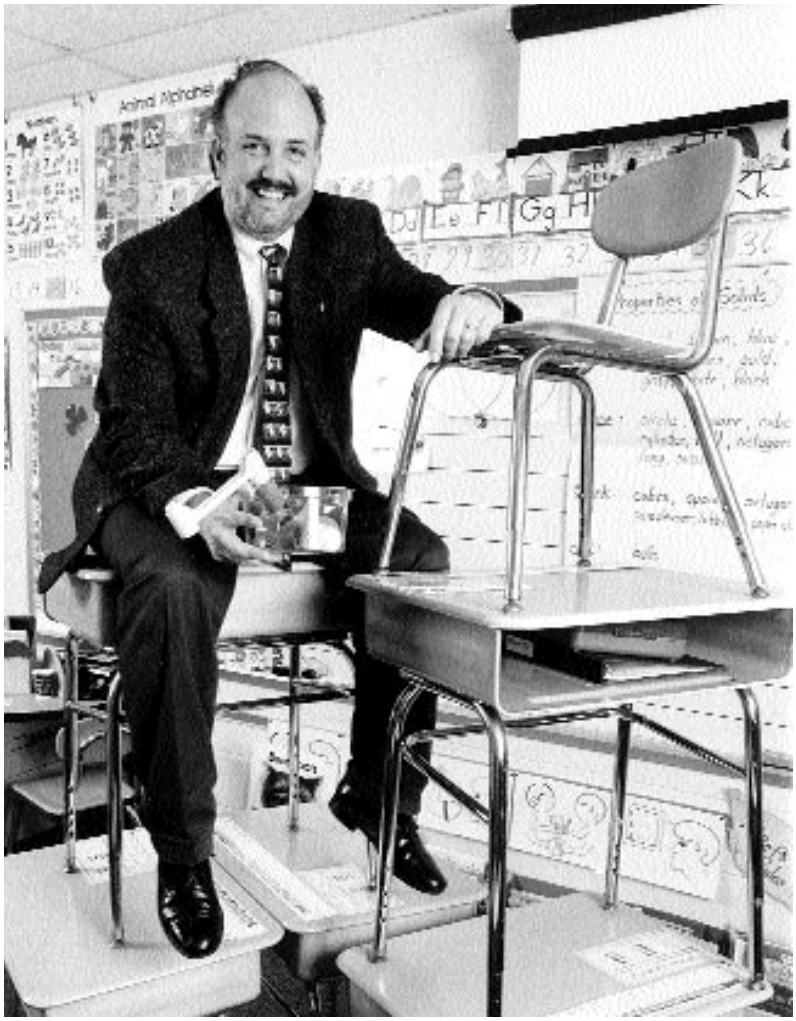
"Seeing the great things the MISE program has done for my kids, I can only imagine what it can accomplish for others who don't have special needs," says Fink, who has been a special ed teacher since 1980.

All of Fink's students are at least three years behind in language development in terms of being able to understand and to express themselves with language. But their communication disorders have no apparent cause—that is, the children have no hearing loss, no social or emotional disability that would delay language acquisition and no physical impairment related to speech. They all have at least an average I.Q. as indicated by one or more performance measures.

The children are enrolled in Gwynedd Square's Communication Support Program, which Fink began in 1992. This early intervention program for students in kindergarten through 2nd grade draws students from all 13 elementary schools in the North Penn School District. Fink explains that early intervention is critical for these children, because brain processes related to language development are more or less complete by the time a child is 8 years old.

So where does science come in?

According to Fink, science instruction is now a major vehicle for language development for his students, largely because of the high-quality teacher training and materials provided through MISE. Fink learned through his own professional development experience the value of inquiry-centered learning. In Fink's classroom, inquiry learning means that students (1) ask a question, (2) make a prediction, (3) devise a plan, (4) check it out, and (5) report their findings. All involve language.



**In Jack Fink's classroom, desks and chairs provide convenient teaching tools to illustrate the concept of stacking.**

Fink says the first question he considers in orchestrating any science lesson is "What is the language component?" The inquiry method

provides "a great opportunity to challenge these kids and get them to perform with language. All of the students demonstrate average abilities in math and science, so it was a real natural fit to get them to work on language skills with topics that already interested them." And to add to its appeal, Fink says, the inquiry method works well with math and reading, as well as science.

*"I'm a much more effective kid watcher now, assessing what they know, assessing their prior knowledge and seeing how they bring it to bear on what they do in the classroom."*

Fink's students follow the same K–1 science curriculum as that used in regular classrooms. It includes units on weather, solids and liquids, comparing and measuring, and plant and animal life. Each unit uses modules that contain materials for a variety of "hands-on" activities. But Fink says the MISE program "moves students from 'hands-on' to 'minds-on.'" Whereas simple hands-on exercises may be no more than what Fink describes as "cookbook activities," requiring students to do little other than follow a list of directions, the inquiry approach uses the materials to engage students in science investigation. Fink's students generate questions to begin the inquiry process, and they often go beyond the stated objectives of the science kits.

Last year, for example, during the unit on solids and liquids, the class was studying physical properties of various objects. One of the activities required that students distinguish between things that stack and things that roll. Fink knew that many of his students didn't know the meaning of "stack" and "roll," so he launched the lesson in a rather unorthodox way. "We stacked all sorts of stuff, including chairs and desks," he says. "Then we went outside and the kids rolled down a hill."

When everyone understood the concepts, they were ready to work with the objects in the kits and classify them as stackers or rollers. The students soon began experimenting further, however. After determining that metal balls were rollers, they discovered that the balls rolled at different speeds depending on the angle of the surface they were rolled on—an activity that enabled them to pick up the meaning of the words "fast" and "slow."

The inquiry process was the underpinning of Fink's professional development as one of five "Leader Teachers" at Gwynedd Square. Leader Teachers are individuals who have participated in MISE's Leader Teacher Institute, an intensive three-year professional development program. He had responded to a notice inviting teachers from the district to participate in the Institute. He says he was impressed that the invitation had been extended to special ed teachers as well as regular classroom teachers.

Fink says the inquiry process has helped him grow considerably as a teacher. "I'm a much more effective kid watcher now, assessing what they know, assessing their prior knowledge and seeing how they bring it to bear on what they do in the classroom."

*"There were no science kits for special needs students, because it was assumed the kids couldn't do that kind of work."*

But many would argue that it's the students who have experienced the greatest changes as a result of the MISE program. Fink says that before MISE, science education for special ed kids consisted of whatever the teacher wanted to do. "Everything was textbook-based. There were no science kits for special needs students, because it was assumed the kids couldn't do that kind of work," he says. MISE was instrumental in changing that, according to Fink. "They made it clear that science really was for all." ◂

*MISE Volunteer*

# Murray Is Living Example of Science Diversity

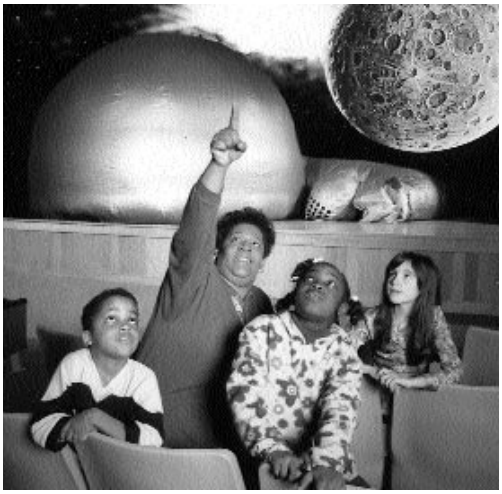
As a classroom volunteer, Merck employee Karen Murray is determined to demolish the popular stereotypes about scientists and to show students that science is for everyone. "It's not about pocket protectors," she says. "And it's not just for the top 3 to 5 percent of the population. Science is for people from all walks of life."

Murray notes that just by being who she is—an African American woman with a degree in chemical engineering and manager of a Safety Devices Engineering Group at Merck—she gets that message across. She says science and math were her favorite subjects in school, and she wanted to become a teacher. Discouraging words from her family regarding teachers' salaries led her to change her mind and pursue a career in engineering instead. But her current volunteer efforts allow her to tap into those early inclinations toward teaching.

She is not alone. Murray has been a classroom volunteer since 1993, when the MISE program began. Since then, many Merck employees have become mentors and classroom volunteers. "Many of our volunteers can point to an early classroom experience that became the spark for a lifelong interest in science," says Maren Reeder, manager of education outreach for MISE.

Murray uses a variety of materials to introduce young students to science concepts. For example, growing something called "Wisconsin fast plants"—a species developed at the University of Wisconsin—provides a way to observe the complete cycle of plant growth in a time span that acknowledges children's typical lack of patience. "We go from seed to bushel in just six weeks," Murray says. The students plant the seeds, tend the seedlings, pollinate the plants using Q-tips, and eventually harvest a crop of fruits that resemble beans.

Studying "phase changes" may sound rather intimidating, but when it's accomplished by making ice cream, arousing student interest presents less of a challenge. Murray has the students combine all of the ice cream ingredients in containers; then they put the containers inside larger containers filled with ice and salt to begin the process that will change the liquid ice cream mixture into a solid. By omitting the salt in one set of containers and showing the students that the mixture doesn't freeze, Murray gets the children to think about the processes involved, ask questions, and pose possible answers.



**Merck employee volunteer Karen Murray prepares students for a portable planetarium adventure.**

Murray says that even though young students may not be able to perform more sophisticated science experiments or calculations, it's this kind of simple observation that can lead to real understanding in the classroom.

Her own children were the main inspiration for Murray's decision to become a volunteer. As an involved parent, she recognized the role she could play in enhancing science instruction, and, she says, volunteering is an indirect but effective way to let her children know about the importance of science.

Access to Merck resources enabled Murray to contribute to her children's classroom science experiences in ways that most parents can't. Last year, for example, when her daughter's class was beginning a unit using microscopes, Murray was able to bring in flea larvae and sheep parasites. "We had a lot of fun looking at those," she says.

Murray is hopeful that through her work, students will abandon their preconceived ideas. "They'll learn about the contributions of many individuals, particularly minorities and women," she says. "And by having fun with science themselves, they'll learn that science is for everyone." ◂

## National Science Resources Center Publishes Guide for Middle School Teachers


For a number of years, school districts have been challenged by the difficult task of selecting curriculum materials that emphasize inquiry-centered science instruction to fit the diverse needs of students, and that are consistent with the National Science Education Standards.

Relief is now on the way. The National Science Resources Center, with the support and guidance of the Merck Institute for Science Education, has published a 480-page resource guide for teachers and others charged with making local curriculum decisions for middle school students. Its release follows the very successful publication a few years ago of a similar guide for elementary school educators.

"Our search for materials for this guide was comprehensive," writes Douglas Lapp, NSRC's executive director, in the book's preface, "and the evaluation process was extensive and thorough. We believe that this compilation will prove to be a valuable resource for middle school science teachers."

*Resources for Teaching Middle School Science* describes 400 curriculum titles for science instruction in grades 6–8. Most of the resources cited in the guide incorporate investigations, simulations and extended projects that support inquiry-based instruction.

The guide is available free on the Web at www.nap.edu/readingroom, or it may be ordered for $24.95 plus shipping from the National Academy Press, 2101 Constitution Ave, NW, Washington, D.C. 20418; tel 1-800-624-6242. ◂

## MISE Represented on Teaching Standards Board

New Jersey has established the state's first Professional Teaching Standards Board, an oversight agency that will be responsible for setting high standards for teachers' professional development.

The state's former commissioner of education, Leo Klagholz, Ph.D., named Carlo Parravano, Ph.D., director of the Merck Institute for Science Education, and 18 other individuals to the board in January. Members include 10 classroom teachers, two college representatives, three district administrators, two members of local boards of education and two members of the general public.

The board will have a critical role in implementing New Jersey's continuing education plan. A part of the plan requires teachers to refresh their knowledge and skills by completing 100 hours of continuing education every five years.

Klagholz says the training will emphasize expanding the skills and knowledge teachers need to help their students meet the state's core curriculum standards. Parravano co-chaired the committee that developed the state's science curriculum standards. The standards were approved in 1996 and specify what children should know and be able to do when they graduate.

"The board will review and screen all professional development activities offered by colleges, professional associations and other providers to assure that all state-sanctioned activities meet the rigorous professional development standards they have established," Klagholz says.

In addition, within five years the board will define for itself an independent role through which it will establish and advocate broader standards of professional development and conduct. ◂

# Merck's Commitment to Science Education

Six years ago, Merck & Co., Inc. made a 10-year commitment to improving teaching and learning in science in the public schools. That commitment, which took shape as the Merck Institute for Science Education, is beginning to bear fruit. According to outside evaluators, "The Merck Institute's approach has been systemic. While it has provided financial support for purchase of new instructional materials, professional development and technology, the core of its work with the partner districts has been the development of a shared vision of the instructional practice needed to help all students reach high standards of performance."

The Institute's overall goal is to raise the levels of participation and performance in science for all students in prekindergarten through 8th grade. MISE began its work by establishing a partnership with four public school districts: Linden, Rahway and Readington Township in New Jersey, and North Penn in Pennsylvania. MISE chose these sites because Merck has major facilities in or near these communities, as well as a history of working with the communities on various science education activities. The partnership currently involves more than 800 teachers in 34 schools.

As part of its systemic approach to reform, MISE strives for the establishment of clear and consistent policies at both the individual school level and the district level. These policies must address all aspects of the education system, including curriculum, assessment, professional development of teachers and administrators, school management and allocation of resources. Merck hopes that, in MISE, it has created a model of school-business collaboration that will inspire similar efforts across the nation. ◂

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**About the Merck Institute for Science Education**

The Merck Institute for Science Education was established in 1993 with a long-term commitment by Merck & Co. Inc. to improve science teaching and learning in the public schools. MISE's work with its partner school districts is supported also by a five-year grant from the National Science Foundation.