



## OF SCIENTISTS AND SCHOOL SYSTEMS

Leon M. Lederman

This is an essay on science education and the efforts of some physicists, aided and abetted by other well-meaning people, to have a significant impact on a large urban school system.

From my point of view, the story started when I left the directorship of Fermilab to join the physics department at the University of Chicago. Secretary of Energy James Watkins, then newly arrived at DOE, had asked what Fermilab and Argonne National Laboratory could do to help the Chicago public schools. School reform was in the air in Chicago, and I began attending meetings to find out what was going on. A consortium of parents, teachers, and people from universities and the business community had combined to pass the most radical school reform legislation in the nation. School-based management came in with a vengeance. Some 540 schools in Chicago are now, in principle, masters of their own educational fates.

Among the leaders of the effort that produced this victory were physicist Gordon Berry of Argonne and physicist Henry Frisch and his astrophysicist wife, Priscilla, both of the University of Chicago. We discussed Secretary Watkins's question, and out of this discussion bubbled up a glowing idea. Perhaps it didn't glow all at once (and perhaps much of the glow was added by others in our group, which included teachers, education professionals and community activists), but glow it eventually did.

A major contributor to the failure of the educational system is the state of large urban school systems and schools in poor rural areas. In large inner cities, the poverty level varies between 40% and 70%. One child in

eight, overall, goes hungry at least part of each month. Children may arrive at school suffering from abuse, neglect and lack of food and medical care. There are many programs designed to address these appalling statistics. However, the best of these, Head Start, reaches less than 30% of the at-risk children.

The ultimate tragedy is for children to arrive at school, having overcome whatever obstacles their lives provide from their beds to the schoolroom, only to discover that the teacher is merely marking time. A proper educational experience can stimulate the child, open the door to the joy of learning, make school a place to be, and break the deadly cycle—of failure and dropout, of unemployment and poverty, of drugs and crime, of teenage pregnancy and new children entering the cycle—that looms as the major problem in US education and US society in the 1990s. Either we face this issue head on, or we write off the cities (as we have been doing) and, as a nation, suffer the social, moral, political and economic consequences of having a permanent and growing underclass.

In the "typical city" of Chicago, the population is roughly half minority, but the student population in the public schools is 88% black and Hispanic, 10% white and 2% others. (So much for *Brown v. Board of Education*!) Instructing these 410 000 students are 24 000 teachers. Of these students, 67% live below the poverty level, and 46% never finish high school (and if the truth be told, this appalling number is much higher if the influence of truancy is honestly evaluated). Chicago students score low on all national tests. Crime, drugs, unsafe streets, and old and decrepit school buildings are also part of the educational picture.

Of course there are superb schools in Chicago with excellent, well-prepared teachers. However, the large majority of teachers are poorly prepared for math and science teaching.

It was in this context that our group—scientists, teachers, educators, principals and businesspeople—organized a new entity to focus on the teachers, *all* of the teachers in the city who must teach some math and science. Our idea was to vastly upgrade their knowledge of science and math content and their ability to deliver it to children. Our work was guided by a set of beliefs:

▷ All children can learn—even poor children, even children with little parental support, even children who live in ghetto neighborhoods plagued by gangs and drugs.

▷ The *teacher* is the key to learning. But all too often teachers are not trained in the teaching of math and science and are themselves uncomfortable with these subjects.

▷ *In-service* teachers must be trained in the newest techniques for teaching math and science. It will take too long to fix the educational bureaucracy, although ultimately that must be done as well.

▷ A private academy that combined the talents of scientists, master teachers and people from the private sector, and that worked cooperatively and constructively with the Chicago public schools, would provide a unique mechanism for a massive infusion of new techniques.

▷ This teachers' academy should serve as a permanent support base for teachers—a place to foster the culture of collegiality, to renew knowledge of content, and to enhance familiarity with developments in educational technology, with new science and math teaching methods, and with fellow teachers and enthusiastic scientists.

We organized a not-for-profit entity called the Teachers' Academy of Mathematics and Science. A council consisting of the presidents of the 14 universities and four-year colleges in or around Chicago appoints TAMS's board of trustees, which draws its members from the business community, the universities, the museums,

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## REFERENCE FRAME

Fermilab and Argonne, teachers and their union, principals, the mayor's office, the governor's office, the Urban League, the United Neighborhood Organization (a Hispanic civic organization), the Local School Council and the Chicago Public Schools.

The huge number of children in the Chicago school system created in us a sense of urgency. It sensitized us to scale, to the need to serve the whole city. We scoured the nation for ideas, for the output of the research in cognition and curriculum reform that has emerged over the last decade. We searched for programs and proven ways to intervene in the educational process. We learned the buzzwords: hands-on, activity based, inquiry methods, thinking rather than rote learning, and, don't forget, play and fun—students doing more talking and less listening, working in groups, dealing with open-ended questions, nurturing the innate curiosity with which they come to school.

We didn't have to look far. Many new programs were being tried out in Chicago, usually by scientists reaching out in their "spare" time. We had Teaching Integrated Math and Science, or TIMS, invented by physicist Howard Goldberg and math professor Phil Wagreich at the University of Illinois in Chicago; Math Tools, invented at the University of Chicago; the Science and Math Initiative for Learning Enhancement, or SMILE, invented at the Illinois Institute of Technology by physicist Earl Zwicker; and the Summer Institute for Science and Math Teachers, developed by a gang of physicists and helpers at Fermilab. These are only a few of the initiatives we adopted.

To give you a flavor of one of these programs, TIMS clusters small groups of kids to collect data, organize those data into tables, plot graphs and discuss the results. Depending on the grade level, the data can be a grab bag of paper shapes, the lifetime of soap bubbles or the variation of an optical field of view with distance. It is the teaching-learning-playing activity that captures the interest of both student and teacher.

The Teachers' Academy opened for business in vacant space on the IIT campus in September 1990, with the help of planning grants from NSF and DOE. Under Watkins and his able education adviser, Peggy Dufour, DOE has been a staunch supporter of the project. The department has also encouraged Fermilab and Argonne to be fully cooperative.

We contract with a whole school and accept all the teachers, in order not to return newly trained teachers

to a hostile environment. As of this writing, some 400 teachers have attended our 16-week intensive training, while leaving their classes in care of TAMS-trained replacements. This is only the beginning of a permanent association with TAMS. Continuous follow-up is essential: We use afternoons, weekends and summers, and we send specialists to the schools that have been through the program.

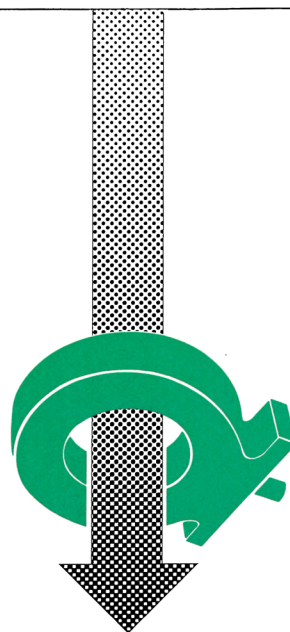
How are we doing? Measuring the value of what we do to make useful feedback available is not easy. We have learned that inner-city teachers really care and quickly develop enthusiasm for the program. Pre- and post-testing are part of the program too. In the schools whose teachers we have trained, science is being taught, and with enthusiasm. We are watching not just test scores but also truancy rates, as well as comments from principals and teachers, but in truth we won't know the results for quite some time.

The program is expensive, and in the current severe budgetary stress felt by the city and the state, the bulk of support must come from Washington, DC—not Darkness and Confusion, but Desirous of Competence (we hope)—the only city in the world where the speed of sound exceeds the speed of light. We have appealed to DOE, NSF and the newly constituted Department of Education—all of which have leaders devoted to the improvement of US education.

With the requested funds (and those we hope to raise locally) we can ramp up from our 10-school beginnings to 30 schools in 1992 and to 100 schools in 1993.

To my knowledge, this is the only action program that responds in scale to the President's romantic goal of making US students number one by the year 2000. For a cost of about \$1 billion, the Federal government can leverage the efforts of enormous intellectual resources in 25 of the most troubled urban centers, as well as extend those efforts to poor rural districts, where educational technology is even more important.

Why are so many of the people involved in TAMS physicists? I'm partly kidding, of course: The help of mathematicians and other scientists in universities and laboratories has been prominent. I think perhaps we are all working off the guilt derived from being paid for what we love to do. However, it may also be that if we scientists don't address the issues in our inner cities (and our poor rural districts) we won't have the new recruits we need to keep our subjects going. ■



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