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Voices from the Reform Movement

by Allyn Jackson

To listen to the voices from the mathematics education reform movement is to hear from a deeply committed group of people, people who are putting all their ingenuity, energy and insight to work on the tough problem of radically changing how mathematics is taught in this country. Over the past decade, this group of professionals – including classroom teachers, education specialists and mathematicians – has built a common vision of mathematics education around richer content, better pedagogy and deeper student understanding. One important supporter has been the Exxon Education Foundation (EEF), whose Mathematics Program, begun in 1987, has made a crucial contribution to the reform effort by providing focused grants to key individuals and organizations.

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The Exxon Education Foundation is celebrating its 40th anniversary in 1995.

The Foundation has been privileged to assist the work of many educators in those 40 years, including the recipients of almost 400 grants for work devoted to improving mathematics instruction. Those awards comprise our Mathematics Education Program which was established in 1987 because we believed in the importance of mathematics for all students, its necessity for serious work in other disciplines and its critical role in business.

To express our high regard for the mathematicians, mathematics educators, and teachers who are the growing source of energy for the movement toward improving mathematics instruction, we asked Allyn Jackson to listen to Voices from the Reform Movement and tell us what she learned.

These "Voices" are engaged in a vital "conversation" about teaching and learning mathematics. The *Humanistic Mathematics Network Journal* is an important element of this conversation. We are pleased to have been able to assist with the Journal's creation and with its growth, and we are grateful for the efforts of its editor, Professor Alvin White, its many contributing authors, and for its readers who sustain and extend this "conversation."

This article first appeared in the program for the National Council of Teachers of Mathematics' 75th anniversary meeting, held in Boston in April 1995. It has been the Foundation's privilege to assist with each of the projects you will find in Ms. Jackson's story. We hope you will find your "voice" here and continue your contributions to these conversations.

*Edward F. Abnert, President
Exxon Education Foundation
Irving, Texas
August 1995*

"So many people have little respect for schoolteachers. People ask me what I do, and if I tell them about my business, they're curious and interested.

But if I tell them, 'I'm a schoolteacher,' I get bored looks. But I still say I'm a schoolteacher, because I want people to know that teachers have deep, deep passion about their work."

*Marilyn Burns, Educational Consultant,
Marilyn Burns Education Associates*

A Vision for Reform

"We at the NCTM had a unique opportunity to do things ourselves. When we didn't get funding to do the Standards, we said, 'Okay, we're going to invest our own money and do this', which was good because we weren't in anybody's pocket. But the fact that, once we got started, we were able to garner the support of groups like the Exxon Education Foundation really made it a wonderful opportunity to make an impact on the thousands and thousands of teachers out there. I think we were pretty gutsy."

*Shirley M. Frye, Educational Consultant and
President of the NCTM 1988-1990*

RVoices from the Reform Movement

The Exxon Education Foundation is "taking a very courageous kind of position," says Kathleen Martin, professor of mathematics education at Texas Christian University. "They have a long-term view which does not demand immediacy. So many people want an immediate bang for their buck, and you can't get that in a complex setting [like education]. The Foundation seems to respect that."

"People would say, 'But don't the kids still need to learn their 'math facts' and their multiplication tables?' I'd say, 'Of course!' Obviously, there are some things that you have to know, that are basic tools. It's just that the mathematics that's been taught in the schools – and to a certain extent in the colleges – in this century has been focused so exclusively on technique. I mean, all those integration techniques – who needs that now?"

*Marcia Sward, Executive Director,
Mathematical Association of America*

This country is accustomed to hearing about how lousy American kids are at mathematics. Opinions may differ on the standardized tests that reinforce this message, but few believe that the mathematics education kids get today prepares them well for tomorrow's world. With technology allowing business and industry to bring more quantitative mathematical approaches to bear on what they do, employers are finding that the young people they hire don't have the necessary skills. The mathematical sciences are reaching into every field of human endeavor, and kids are easily locked out of opportunities because of deficient mathematical preparation. Consensus has grown that math class should prepare students to tackle a wide variety of mathematical tasks, not just page after page of arithmetic drill.

In 1989, the National Council of Teachers of Mathematics published *Curriculum and Evaluation Standards for School Mathematics*, which provided an ambitious vision for change. At the time, talk of national standards was seen as a threat to the autonomy of local school districts. In addition to the political risk, NCTM also took a financial risk, sinking over \$1 million of its own money into producing the *Standards*. "If it had been a colossal failure, it would have had serious ramifications for the NCTM as an organization," says Glenda Lappan, a professor of mathematics at Michigan State University, who worked on the *Standards* project.

As it turned out, the *Standards* have been a

tremendous success. Not only have the *Standards* revolutionized thinking about mathematics teaching and learning, they have also paved the way for educational standards in other areas such as science, social studies and the humanities. The *Standards* have gained international attention as well – even in Japan, where mathematics test scores leave the U.S. in the dust, interest in the Standards is high. “When we were initially involved in this, I thought there was a real possibility that this would be a document that would be produced, put on a shelf and occasionally looked at by a school curriculum developer,” Lappan remarks. “And it has in fact been a document around which there has been a worldwide conversation.”

Two years after the *Curriculum and Evaluation Standards* appeared, the NCTM issued a second set, *Professional Standards for Teaching Mathematics*. A third set, on assessment, appeared in 1995. EEF has supported these efforts by providing funding for dissemination as well as for other projects, such as an examination of the impact of the *Curriculum and Evaluation Standards*. The basic thrust of the *Standards* is to put the student at the center of learning, with the teacher acting more as a coach than as an authority figure who has all the right answers. The idea is to make mathematics a living, breathing subject that students can talk about, play with and use. Don’t sentence kids to solitary confinement with a page of arithmetic drill, say the *Standards*; give them problems that mean something to them, get them talking to each other and discovering their own mathematical ideas. The *Standards* recognize that this can only happen if

“Industry, especially small industries, are just not able to get an adequately trained workforce to do what they need done...What we’ve seen over the last ten years is a major change in the use of technology in the workplace, especially computers, but not just computers. The forklift is obsolete now. Robots are in.”

Phillip Griffiths, Director, Institute for Advanced Study, Princeton

teachers have a solid understanding of mathematics and are treated as professionals who are responsible for creating a rich mathematical environment where learning can take place.

Building a Community

“One of the major accomplishments of the mathematics education reform movement has been to create a ‘mathematical community’ from among the many diverse professional societies in the mathematical sciences and to unify their attention on the importance of educational quality at all levels. Although many fissures remain within this community, individuals at all levels now speak with each other and are beginning to take responsibility for mathematics education as a single seamless system.”

*Lynn Arthur Steen,
Executive Director, Mathematical Sciences Education Board*

The people working on mathematics education reform have been remarkably successful at drawing into their fold a variety of groups having an interest in seeing mathematics education improve. The Mathematical Sciences Education Board (MSEB) has been responsible for much of the success of this alliance. Created at the National Research Council in 1985, MSEB serves as a broker for mathematics education reform, bringing together not only teachers and curriculum supervisors, but also people whom one would not ordinarily expect to see discussing mathematics education reform – researchers from national laboratories, CEOs from high tech industries, scientists, mathematicians and representatives from the media. With EEF as one of its major supporters, MSEB has worked in close collaboration with the NCTM to broaden consensus about the *Standards*.

EEF has also supported one of MSEB’s most successful outreach programs, the State Coalitions. Begun in 1989 and now operating in most states and the District of Columbia, the Coalitions are like mini-MSEBs operating at the state level. Activities vary from organizing teacher in-service programs to working with politicians to change educational policies at the state level. In 1995, the

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State Coalitions reached a milestone by creating their own national organization, the National Alliance of State Science and Mathematics Coalitions. Some of the Coalitions have established strong links to business and industry, while others have joined forces with groups working in science education reform. Together, the State Coalitions provide the mathematics community with a crucial link to local reform efforts.

Bringing in the voices of mathematicians has been an important development in the reform effort. As the group with the deepest understanding of the subject and its connections to other areas, mathematicians clearly have an important contribution to make to discussions of what it is about mathematics that is most important for students to learn. There have been calls for more emphasis on probability and statistics, on shape and geometry, on combinatorics and discrete mathematics – which is the right path to take? Answers to such questions must grow out of conversations between mathematicians and mathematics teachers.

Each summer, the Park City/IAS Geometry Institute, sponsored by the Institute for Advanced Study, brings together research mathematicians, graduate students, undergraduates and high school mathematics teachers for a three- or four-week session. “You get the best cooperation when these people are talking about common interests, and their common interest is education,” says John C. Polking, a professor of mathematics at Rice University and director of the Park City Institute. “The teachers have a lot to offer the researchers because they are the experts on teaching, much more so than the typical researcher. And the researchers can offer a lot about mathematics that may not be known to the high school teachers.” Polking says that his contact with teachers at the Park City Institute has inspired changes in his own teaching at Rice.

Bringing Vision to Life

The influence of the *Standards* is everywhere. People interviewing for jobs as mathematics

“We’re at the stage where the vision of the Standards defines pretty much what we want to accomplish.

In some sense, we have a picture of what the ideal looks like.

And then the question is implementation.

That totally dwarfs the problem of defining the vision.

The idea of making that vast a change, at the level of ambition of the Standards, all around the country, is almost unthinkable

And a lot of people think it’s naive and it can’t be done in this country.”

Hyman Bass, Professor of Mathematics, Columbia University, and Chair, MSEB

teachers are routinely asked about the *Standards*. Just about every mathematics education proposal to the National Science Foundation mentions the *Standards* somehow. Across the country, groups working on mathematics curriculum frameworks and testing programs at the state level have made serious efforts to align their work with the *Standards*. Most secondary school teachers and many middle school and elementary school teachers are aware of the *Standards*.

But are educational practices really changing? “When you move to how many teachers are systematically trying to analyze their practice and move towards the *Curriculum and Evaluation Standards*, then the numbers go down,” says Lappan. “There’s an awareness level, there are people who are trying to get on board, trying to think hard about what they’re doing. But clearly this is a reform that’s going to take a very long time.”

One of the toughest jobs is at the elementary level, where many kids turn off to mathematics and where teachers often have weak mathematical backgrounds. EEF is investing in this area, through its K-3 Mathematics Specialist program, which is the most extensive and the longest running of the Foundation-funded mathematics programs. Seventy-five K-3 Specialist projects in twenty-eight states have received EEF grants. All of the projects are guided by the *Curriculum and Evaluation Standards*, but “EEF is not interested in pushing any particular program,” explains Pat Hess, the facilitator for the K-3 Specialist projects. “You couldn’t go to the store and purchase the ‘Exxon Education Foundation Project’ program.”

This diversity is the key to the success of the K-3 Specialist program: Teachers begin to dis-

RECLAIMING INTUITION IN MATHEMATICS

"For me, math is like falling down a giant waterfall. Going down is fun and easy, but once you hit the bottom, you are thrown about by the force of the water. It's a challenge to see if you can 'beat' the water and survive or whether you will just give up and let the water get the best of you. Eventually if you stick it out you move on to calm waters and everything is fine...until the next fall."

"For me, math is like climbing a huge mountain. It is terribly difficult going up, yet when you get there, you know you've accomplished something."

"For me, math is most like a fog because you cannot see or understand where it came from, but you just have to keep moving forward. You can only move forward slowly, otherwise you'll get lost."

"For me, math is a never-ending list of rules that don't really mean anything. Math seems to be the most indecisive subject there is. In the beginning we were taught basic math, like, you can't subtract four from one. That seemed logical to me. Then they told us that you could do that, but it equals a negative number. A negative number is less than zero. Zero is nothing. How can anything be less than nothing?"

These "mathematics metaphors," with their vivid expressions of the exhilaration, confusion, and frustration of learning mathematics, were written by high school students. They appear in a book which was edited by Dorothy Buerk, a mathematics education professor at Ithaca College, and published in 1994 by the NCTM.

The book grew out of a project, funded by the Exxon Education Foundation, in which Buerk met with teachers to discuss classroom strategies for implementing the NCTM *Standards*. Entitled "Empowering Students by Promoting Active Learning in Mathematics: Teachers Speak to Teachers," the book provides ideas for cooperative learning and using writing in the mathematics classroom. Out of the project grew CLAM, the Cooperative Learning Alliance for Mathematics, through which Ithaca-area teachers in grades five through college meet once a month.

"My belief is that one of the major problems for students is their perception of mathematics as something that's rote, something in which they have to shut off their own thinking and try to reproduce somebody else's thinking, without having it make sense to them," says Buerk. "The metaphors give clues about the students' learning strategies and their conceptions of mathematics. This helps the teacher deal with them individually in different ways."

cover the conditions that allow reform to happen in their schools and districts. They are given the means to develop their own ideas for how to improve teaching and learning in mathematics. For many of them, improving their own mathematical backgrounds becomes a natural next step. In addition, the teachers have formed a community in which they can share ideas. Hess puts out a newsletter that describes activities of the projects and, each September, the K-3 program brings the teachers together for a conference. Some of these teachers have become leaders of change at the regional or state level.

Marilyn Burns, an educational consultant in Sausalito, California, runs in-service programs in mathematics for elementary school teachers which reach 7,000 to 8,000 teachers each year. She calls the K-3 Specialist program "fabulous," noting that the flexibility EEF allows for the projects "mirrors the kind of flexibility I want teachers to allow for students learning different ways." "To me, teachers are the key," Burns declares. "You can change materials, but a unit is just a unit. Without changing the teachers' belief systems, attitudes, understandings and instructional approaches, you're not doing anything, because they're the ones who are seeing children for six hours a day."

Assessment Issues

"Evaluation has become a political carrot: Standardized tests that children take as often as four or five times a year are used as a way to evaluate teachers and schools, sell real estate and further the ambitions of politicians. Houses are advertised as being in school districts with above-average test scores; secretaries of education point to test score graphs as though they were some sort of Dow Jones average. Lost in this numbers blitz is much concern about how the constant and continual testing in schools affects the day-to-day learning of individual children."

*Susan Obanian, from her book entitled
Garbage Pizza, Patchwork Quilts, and Math Magic*

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At the same time that many teachers are wading into deeper mathematical waters by using manipulatives, open-ended problems, student groups and other innovative methods, the tyranny of standardized testing remains. "I know for a fact that teaching stops at least three to five weeks before the tests," Marilyn Burns observes. "I can't tell teachers not to prepare their kids for tests if those scores are going to be published in their local paper. Teachers don't lose their salaries, they don't lose their jobs, but it's a pall that hangs over them – 'Oh my God, how are the kids going to do on the test?'"

Standardized testing is a major stumbling block to implementing the *Standards*, because the tests do not measure what the Standards say is important for students to learn. For reform to happen in a lasting way, all three parts of the educational triad of teachers, curricular materials and assessment must change together. The NCTM's *Assessment Standards* will provide some guidance on these issues. This set of standards was carefully developed to align with the other NCTM standards for curriculum and for teaching.

School systems around the country are experimenting with new ways to assess what kids know in mathematics. One such program in Bellevue, Washington, funded by EEF, has an unusual twist. It brings parents and administrators in on the ground floor of the development of the new assessment methods, such as portfolios. Led by Sherry Beard, elementary mathematics specialist for the Bellevue public schools, the program brought together a team of eighty people – parents, teachers and principals – to formulate goals for mathematics in grades K-5 and to explore ways of assessing whether those goals are being met.

With help from EEF, MSEB issued *Measuring Up*, a set of prototypes for fourth-grade assessment. One prototype asks students to look at five different bar graphs and decide, based on the characteristics of the graphs, which one could represent the heights of students in a fourth-grade class, which one could represent the distribution of cavities, which one could represent the distribution of their mothers' ages and so on. A look at the sample student responses shows how these prototypes give a far richer view of what the students do and do not understand than any bubble-answer test could.

Start Pitching In

"The textbook people say, 'Well, we're not going to change because of the tests.' And the test people say, 'We're not going to change because of the textbooks.'... Everyone's got the 'because, because', and really, everything has to change at once. 'So don't be waiting around, start pitching in,' is my thought. So the Exxon Education Foundation says, 'We'll pitch in,' and I say, 'Hallelujah.'"

Marilyn Burns

The strength of the Mathematics Program of the Foundation is that it invests in people – savvy, dedicated people, each of whom contributes a unique strength, a unique voice to the tough job of reforming mathematics education. And their voices are being heard. "People say, 'The mathematicians really have their act together,' or 'Mathematics is leading the reform effort,'" notes Marcia Sward. "I think that we have charted out new ways of thinking about the whole educational system."

But more is needed. To get change going in our 16,000 school districts and 3,000 colleges and universities, the entire nation has to join the chorus. "One thing that is going to make a tremendous difference over the next few years is whether or not we can find a way to articulate the intent of this mathematics vision so that parents and community leaders and business and industry buy in and help support it," says Glenda Lappan. "We need to find ways to develop this sense of ownership and support in individual communities across this country." Bringing all of these voices into the melody, to discuss and debate and find common ground, is what it will take.

Listen to the voices of the reform movement. Each is a little different, but they're all singing the same song and rejoicing in the same harmonies.

Allyn Jackson is the staff writer for the American Mathematical Society.