Developing *Mathematics in Context* (MiC)

By Thomas A. Romberg

There were several influences on why and how we developed *Mathematics in Context*. First, I was chairman of the NCTM Commission on *Standards* that produced the 1989 NCTM *Curriculum and Evaluation Standards*. We had laid out a vision in the *Standards* for a changed mathematics curriculum. At the time, I was also the director of the National Center for Research on Mathematical Sciences Education, funded by the U.S. Department of Education. The research done over the last 20 years made it very clear that there were some features of teaching and learning that needed to be incorporated into the way materials were developed. Materials were only a necessary part of a reform strategy—necessary, but not sufficient to produce reform on their own. In order to change mathematics teaching and learning, you needed to provide a lot of professional development for teachers, and you needed to change the assessment systems that are used in schools to judge progress, as well as make other changes.

About that time, as a part of the background work we had been doing in the development of the *Standards*, I became familiar with the work of the Dutch at the Freudenthal Institute in Utrecht. The Dutch had been, for the previous 20 years, implementing what they refer to as a “realistic” mathematics program in schools. The program is based on the ideas of Hans Freudenthal and others, and is centered on the notion that mathematics is a sense-making device. Students need to engage in trying to make sense out of real problems, and the development of mathematics needs to be from that point of view.

As part of our research, we worked with the Dutch, trying out some things. I contracted with them to do a small study in Wisconsin, teaching a unit in statistics for high school students. Gail Burrill, who later became president of NCTM, was the chair of the math department at the time and agreed to participate in the study. From that study, we saw that the kind of approach the Dutch were using was very interesting, and we tried to incorporate it into a proposal for developing a middleschool program. So the background of *Mathematics in Context* is really a combination of three things: the NCTM *Curriculum and Evaluation Standards*, the research base on a problem-oriented approach to the teaching of mathematics, and the Dutch realistic mathematics education approach. We submitted a proposal to develop a middle-school program combining those ideas, and that program became *Mathematics in Context*.

I should note that although a substantial part of the ideas behind the program are from the Dutch approach, the materials themselves are not a translation of Dutch curriculum materials. The materials were developed here by staff at the University of Wisconsin–Madison, with the assistance of the Dutch, and of course, also with the assistance of a number of middle-school teachers who pilot tested and field tested the materials and provided a lot of feedback on the appropriateness of the materials for American students.

The Mathematics of MiC

Mathematics in Context is organized around four mathematical strands: number, algebra, geometry, and statistics and probability. The number strand is built on the assumption that whole-number arithmetic would have been covered fairly well in any program up through grade 4; we are building on that. There is a fair amount of work in the curriculum on number, particularly on rational numbers—fractions, decimals, and percents. We're especially strong, we think, in work on ratios.

The second strand is algebra: 13 of the 40 units are algebraic, dealing with what we refer to as the transition from informal to pre-formal to formal algebra over the 5th, 6th, 7th and 8th grades. That's a very strong part of the program. Our whole approach is not to talk about algebra just as it always was in the typical 9th-grade Algebra I course. We talk about algebra as a set of tools used to solve certain kinds of problems.In order to be able to solve those problems, students have to learn, for example, to write formulas, study the properties of formulas and equations, and be able to graph and talk about graphical solutions. The focus isn't on doing the typical algebra manipulation of symbols; the focus is on using algebra to solve problems.

The third strand is geometry. Geometry, from the Dutch point of view, and from the work we've done, has much more focus on spatial visualization skills than on learning to identify properties of plane figures—which is the singular focus for geometry in so many curricula.

The final strand of work is in statistics and probability. The curriculum really focuses, in this strand, on beginning notions of dealing with data and representing data. In developing the curriculum, we started with where we wanted to end. We started with the end of 8th grade and said, "By the end of 8th grade, what are the kinds of problems we expect students to be able to solve?" And then we said, "What are the mathematical ideas that need to be developed prior to that? We'll help students deal with those." In developing the program, we would say, "Well, we want students to be able to find solutions to these kinds of problem situations. What are the features associated with that kind of reasoning that need to be developed at earlier stages?"

Instructional Approach

The curriculum assumes students need to be exposed to problem situations that give rise to the need for the mathematics. Some people would look at one of our problems and say, for example, "Oh, well, they need to know algebra first in order to solve that problem." Well, no. We give students that problem before they know how to solve it, in order to give students a sense that they need to generate a procedure for solving these kinds of problems.

We make the assumption that technical skills get developed as a consequence of solving problems. We do provide a *Number Tools* kit that goes along with the materials, so if teachers find that some students didn't pick up, in earlier grades, the skills that they now need, there's some practice available for them. But the program itself wasn't developed in order to teach technical skills. The program was developed to teach students to solve non-routine problems. As a consequence of the need to have certain skills in order to solve non-routine problems, we find that the kids pick up those technical skills as needed.

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Dr. Romberg has a long history of involvement with mathematics curriculum reform. In particular, he chaired the NCTM groups that produced the Curriculum and Evaluation Standards and the Assessment Standards. His research has focused on three areas: young children's learning of initial mathematical concepts[1]; methods of evaluating both students and programs[2]; and an integration of research on teaching, curriculum, and student thinking[3].

1 Best reflected in the *Journal of Research in Mathematics Education* monograph "Learning to Add and Subtract."
2 Best reflected in the books *Toward Effective Schooling: The IGE Experience*; *Reforming Mathematics in America's Cities*; *Mathematics Assessment and Evaluation*; and *Reform in School Mathematics and Authentic Assessment*.
3 Best reflected in the handbook chapters, "Research on Teaching and Learning Mathematics: Two Disciplines of Scientific Inquiry" and "Problematic Features of the School Mathematics Curriculum," and in the recent book *Mathematics Classrooms That Promote Understanding*.