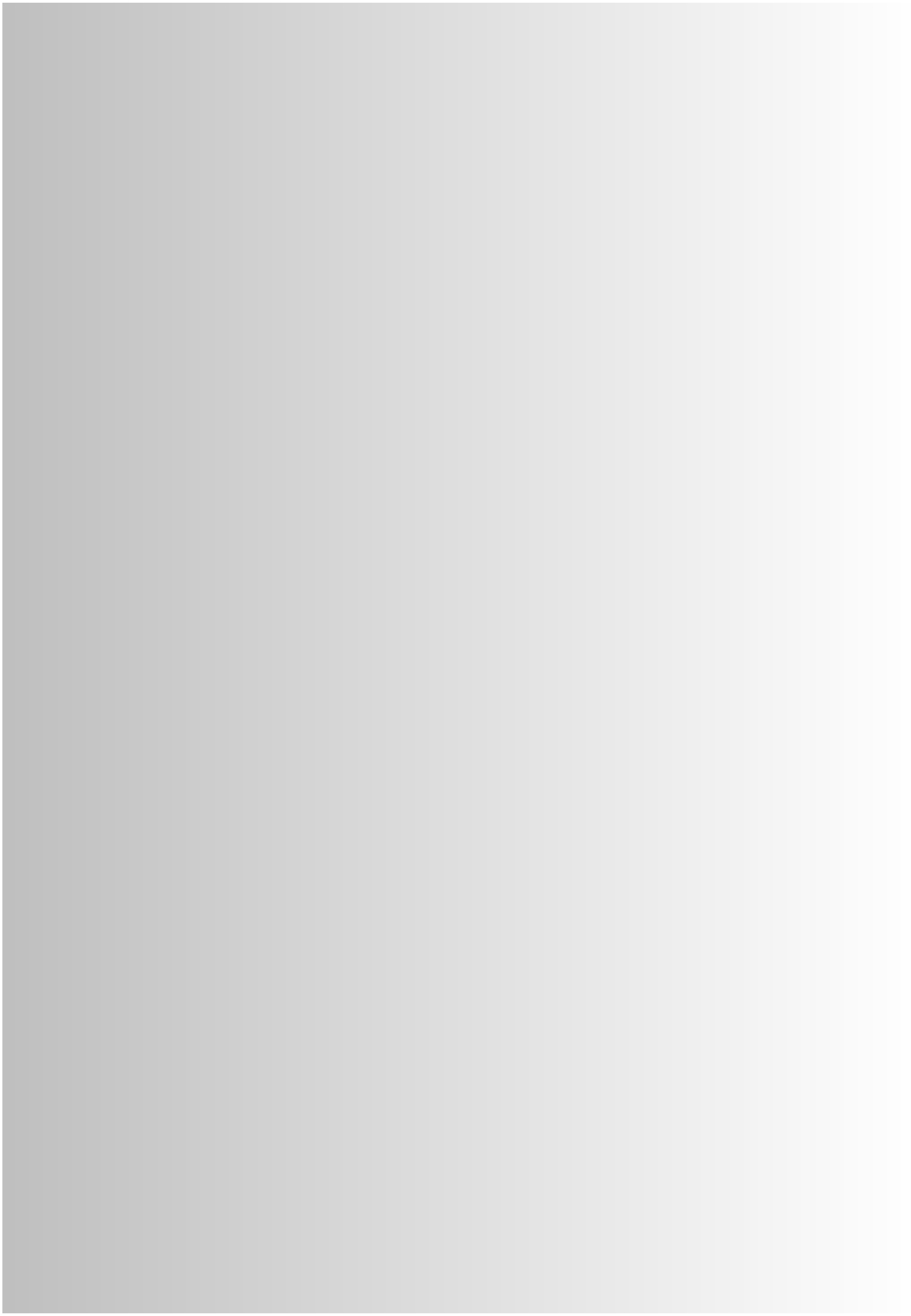
MATHEMATICS IN CONTEXT



MATHEMATICS IN CONTEXT

A middle school curriculum for grades 5–8, developed by the Mathematics in Context (MiC) project.

Mathematics in Context is a comprehensive middle school mathematics curriculum for grades 5 through 8. It was developed by the Wisconsin Center for Education Research, School of Education, University of Wisconsin–Madison and the Freudenthal Institute at the University of Utrecht, The Netherlands.

Connections are a key feature of the program—connections among topics, connections to other disciplines, and connections between mathematics and meaningful problems in the real world. *Mathematics in Context* emphasizes the dynamic, active nature of mathematics and the way mathematics enables students to make sense of their world.

In traditional mathematics curricula, the sequence of teaching often proceeds from a generalization, to specific examples, and to applications in context. *Mathematics in Context* reverses this sequence; mathematics originates from real problems. The program introduces concepts within realistic contexts that support mathematical abstraction.

Mathematics in Context consists of mathematical tasks and questions designed to stimulate mathematical thinking and to promote discussion among students. Students are expected to explore mathematical relationships; develop and explain their own reasoning and strategies for solving problems; use problem-solving tools appropriately; and listen to, understand, and value each other's strategies.

The complete *Mathematics in Context* program contains 40 units, 10 at each grade level. The units are organized into four content strands: number, algebra, geometry, and statistics (which also includes probability). Every *Mathematics in Context* unit consists of a *Teacher Guide* and a non-consumable, softcover student booklet.

The *Teacher Guides* contain the solutions to the exercises; a list of unit goals; and objectives, comments, and suggestions about the approach and the mathematics involved in the unit. The guides include assessment activities for each unit, including tests, quizzes, and suggestions for ongoing assessment. The guides also provide blackline masters for activities requiring students to have copies of the text page.

Also available are two supplementary products for teachers: the *Teacher Resource and Implementation Guide* (TRIG) and *Number Tools*. The TRIG manual is a comprehensive guide for the implementation of *Mathematics in Context*. It addresses topics such as suggested sequence of units, preparation for substitute teachers, preparing families, assigning homework, and preparing students for standardized achievement tests. *Number Tools*, Volumes I and II give students further exposure to number concepts, including fractions, decimals, percents, and number sense. The activity sheets are supported by a context similar to those in the curriculum units and can be used as homework and/or quizzes on classroom activities.

Manipulatives used in the program are items commonly found in the classroom, such as scissors, graph paper, string, and integer chips. As students progress to later units, the need for a personal calculator increases. The 8th-grade units were written with the expectation that students would have access to graphing calculators.

Publisher Contact
Briana Villarrubia
Encyclopaedia Britannica
310 S. Michigan Avenue
Chicago, IL
phone: (800) 554-9862, ext. 7961
fax: (312) 294-2177
BVillarr@us.britannica.com
http://mic.britannica.com

Developer/ Implementation Center
Meg Meyer
Staff Developer
Mathematics in Context Satellite Center
Wisconsin Center for Education Research
1025 W. Johnson Street
Madison, WI 53706
phone: (608) 263-1798
fax: (608) 263-3406
mrmeyer2@facstaff.wisc.edu
http://www.wcer.wisc.edu

THOMAS A. ROMBERG AND MEG MEYER ▸ DEVELOPERS

Thomas A. Romberg is the Sears Roebuck-Bascom Professor of Education at the University of Wisconsin–Madison and Principal Investigator and past Director of the National Center for Improving Student Learning and Achievement in Mathematics and Science (NCISLA) and the National Center for Research in Mathematical Sciences Education (NCRMSE).

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].

Thomas A. Romberg

Developing *Mathematics in Context* (MiC)

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 middle-school 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

---

[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*.

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 nonroutine problems. As a consequence of

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.

Students are given a problem to read and start working on, and they are likely to come up with strategies and techniques that are different from the teacher's.

the need to have certain skills in order to solve nonroutine problems, we find that the kids pick up those technical skills as needed.

Changes for teachers

When schools purchase the *Mathematics in Context* materials, one thing that is critical is to support the teachers for the first couple of years as they try the materials and learn to teach in a new way—in the way that the NCTM *Professional Teaching Standards* argue that we need to teach. We have developed a rather extensive help system for teachers using *Mathematics in Context*. That has been a focus of ours from the beginning because we know that the materials are a necessary but not sufficient set of ideas to reform the teaching of mathematics. Teachers need help doing this.

The teacher's role changes considerably as a consequence of the role of problems in the material. Students are given a problem to read and start working on, and they are likely to come up with strategies and techniques that are different from the teacher's. Traditionally, the approach to problems has been, "Here's a problem. Let me show you how to do it. Now we're going to do a page of more problems like that one." The approach of *Mathematics in Context* is, "Here's a problem. Our job collectively, students and teacher together, is to figure out how we're going to make sense out of it."

Many teachers initially have some difficulty with this change in instructional approach. The kids are working on a problem, and my job as the teacher is not to tell them what to do, but rather to support what they're doing: to challenge their ideas, to get them to share their thinking, to get them to argue about the mathematics. Building arguments is a central part of what learning to do mathematics is all about; justifying your answers becomes critical. And all of that changes the role of the teacher in the classroom.

We think there are a few things that are very important for supporting teachers. Probably the most important is that the teachers have the opportunity to work through the problems themselves before they try teaching them. If they've never dealt with a problem before, or never thought about some of the alternate ways of doing the problem, they will get surprised by what the kids do, how they think, and the strategies they use. The teachers need to do the mathematics themselves. Another important thing is that they ought to be working with a team of teachers, discussing these ideas together. The research we've done has shown that in schools where there have been teams of teachers working together and supporting each other, things have gone a whole lot smoother than elsewhere. Teachers also need help from a resource person. They need to be able to call on somebody—whether it be via the Internet, or in person—who can serve as a resource person for help with the content, the pedagogical approach, the book itself, the setting of appropriate expectations, and so on. Often what happens is that teachers find kids getting excited about something and going off in a certain direction, extending a particular idea. The teachers aren't always sure whether that's a good or bad direction to go in. An experienced resource person can be very helpful at that point.

Teaching to the test

One pitfall that many schools have fallen into is saying, "Well, it's fine that kids are learning to solve problems. But we have to take this standardized achievement test," or a state test, or whatever. So they stop teaching the program, and they spend two weeks or a month practicing to take the test. Our research shows over and over again that it simply isn't necessary to do that. The mathematics is being developed as a consequence of solving the problems in the curriculum. Kids do the same on those external exams—ones that have little to do with what they're being taught—regardless of whether they get pulled aside to do a considerable amount of practice.

Technology

We expect students to have a calculator available to them from 5th grade on. We expect them to use a graphing calculator in some activities in grades 7 and 8. But most of the problems in which students use the calculators are not simple problems that require only the use of the calculator. Most of the problems require the use of your brain to model a particular problem situation. Then, if the calculations get to be complex, of course we expect students to use the calculation tools that are available. The focus isn't on finding answers to small problems, the focus is on struggling with more complex problems where the calculation part is usually a minor part of the problem. This is not a technologically-driven curriculum. *Mathematics in Context* simply says the calculator is a tool that you ought to be able to use when it becomes appropriate—and that you should learn to recognize when it is appropriate.

There were a lot of things that we would have liked to do with the use of computers or applets[4], for example, that we didn't have the resources to incorporate into the curriculum. You can use technology now to make problems much more dynamic than you can in print material.

Impact data

During the pilot testing and field testing of the materials, we gathered lots of data on what students were able to do on the particular units, with respect to the problems they were solving. We collected a lot of data that said, "In most cases, kids did very well." If they didn't do well, or if there were problems, that's where the revisions to the materials came in, in terms of creating the final version of the material. We gathered no standardized test data during the pilot testing and field testing because we didn't think those tests measured what it was we were trying to accomplish. As the director of a research center, I always assumed that materials we were developing were basically tools for our research on the teaching and learning of math and science. So we spent a lot more time examining the impact of certain kinds of materials on kids, or on teachers, than we did in trying to satisfy the typical administrative demand to know how well kids were doing on some standardized test that didn't measure what we were interested in.

However, we are running a major longitudinal cross-sectional study right now on the implementation of *Mathematics in Context* for the National Science Foundation. We're gathering a lot of data, contrasting *Mathematics in Context* classrooms with some traditional classrooms on some standardized measures, as well as on a problem-solving test that the Dutch developed. We're not at the point yet of talking about the results from that data, because the study is still under way. But I can certainly tell you that so far, kids seem to be doing very well with the program. It is also clear from the impact data that the materials themselves—as I argued earlier—are only one component in the change process. The beliefs of

Mathematics in Context *simply says the calculator is a tool that you ought to be able to use when it becomes appropriate—and that you should learn to recognize when it is appropriate.*

[4] Applets are small computer programs taken from the Internet.

teachers, teachers' capabilities in using a problem-solving approach, support for teachers, administrative support, school structures—all of those kinds of things are as important as the materials themselves.

Implementing the NCTM *Standards*

When we wrote the NCTM *Standards*, the central feature of the argument was—as I've been trying to describe here with *Mathematics in Context*—learning to solve nonroutine problems. That's the real goal of a mathematics program. What I see states and local districts doing quite a bit now is taking the NCTM *Standards*, looking at a standard and the bullets under it, and then incorporating those bullets into a list of behavioral objectives that they had in their previous mathematics framework. Then, those states and districts are evaluating new curriculum materials, not on the basis of whether they focus on solving nonroutine problems, but rather on whether they meet all the behavioral objectives that they have incorporated under a particularly large standard. This issue isn't specific to *Mathematics in Context*, but it is about the reform programs more generally and their relationship to the NCTM *Standards*.

What happens with *Mathematics in Context*, and I'm sure with other reform programs, too, is that a state or district will say to us, "We like the program and the problem-solving approach, but here's our framework." That framework is usually a long list of behavioral objectives. They ask, "Can you tell us where the program covers each of these?" We say, "Well, we cover all of that, but for this objective there is a problem in Unit 6 and a problem in Unit 8, and another problem over here..." It isn't like there's a single unit in which students finish with that concept, and where I can point to what we have called in the past "mastery" of that objective. It seems to me that states and districts have fallen back into the behavioral "mastery of objective" kind of framework.

I don't know how to address that, other than simply to tell what it is we've been trying to do, and point out that that isn't what we had in mind when we wrote the NCTM *Standards*. I see all of the reform programs struggling with that. The challenge ahead of us is helping states and districts move beyond saying, "Oh, we love the *Standards*." It's lovely rhetoric, but we need to help people understand what it means when you get down to the details.

Meg Meyer

Meg Meyer directs the *Mathematics in Context* Satellite of the Show-Me Center Project, which supports the implementation of MiC. She was a member of the development team for *Mathematics in Context* and has worked extensively in staff development with teachers using the curriculum. She also teaches in the secondary mathematics certification program at the University of Wisconsin–Madison, where she uses MiC as often as possible to show what a good middle-school mathematics curriculum looks like.

Changes in teachers' practice

Mathematics in Context makes great demands on teachers to change their practice. One of the biggest changes it asks for from teachers is to shift the responsibility for the knowing of mathematics away from the teacher and to the student. That's a difficult shift for a lot of teachers whose experience has been with traditional curricula, where they are the source of knowledge and answers. Now the role of the teacher is much more as the director of the discussions that will lead to a rediscovery of significant mathematics. The director helps students compare alternative ways of looking at problems, and to figure out what's correct, because there's not always one clear answer. The program also asks teachers to interact with new mathematics. The curriculum contains mathematics that is not typical for grades 5 through 8 and, therefore, really stretches teachers' mathematical knowledge.

So teachers are learning new mathematics, and the norms of the classroom have changed. There are also a lot of management issues teachers face that are related to the curriculum: they need to think about how to organize materials, how to group kids, how to manage discussions, even how to handle the noise level. Those are all things that teachers have to grapple with in order to get started.

Professional development

The single most important thing that has to happen to support teachers and prepare them for these changes is that the teacher must do the mathematics as if he or she were a student. Not only is it the most important thing, but it's probably also the most difficult thing to ask of teachers. It represents a commitment of time that most of them don't have. There's also an element of risk in it, because if they engage in the mathematics as a student, they're likely to discover that they don't know how to do it. Doing the mathematics as a student also means engaging in it with other teachers, which forces a collaboration that is frequently not present in schools. So it can be difficult—but it is the key—for teachers to get involved with doing the mathematics.

There are different ways to involve teachers in doing the mathematics. One way that has been very successful in the New York City area is what we call "Module of the Month." Someone with real familiarity with the program—often it's someone like me—travels there and meets with a large group of teachers once a month, and we work through an entire unit in a day. Now, obviously, there are some constraints on that process. One is that in order for teachers to have the opportunity to come, the district must plan for substitutes. There's also a monetary commitment that provides that outside expertise. In a big district like New York, where there's a huge purchase of materials, then that's part of the package in the sale. I think our publisher, Encyclopedia Britannica, has done an outstanding job of supporting professional development as it makes sales to districts.

There are districts where the sales are not large enough to support that kind of professional development—but that does not preclude the same kind of thing happening under local leadership. Ames, Iowa, did it without using outside experts. They formed study groups and went through the units together. A study group might look, for example, at how a concept builds through a mathematical strand. They did these things on their own initiative, so I know it's possible. It takes, I think, strong leadership within the district to make those things happen.

…in order to successfully make the kinds of changes that these new curricula require, districts have got to take a long view of implementation.

Working with parents

In *Mathematics in Context*, more so than in a traditional curriculum, teachers have to grapple with parents' perceptions of the curriculum, and their perceptions of what is appropriate mathematics. Parent concerns really range from "My kids need to know the basics," to "My kid is gifted and talented and, therefore, should not be in this curriculum." I think that having a proactive, rather than reactive, stance to parents is important. Teachers and schools need to communicate with parents up front about the changes they anticipate, keeping it all very positive. "We're going to be doing wonderful things. Please come in and visit." Being welcoming and open with parents can really help. Parent nights and family math nights can also be very powerful.

There are some articles that can help teachers respond to specific parent concerns. Two things come to mind that give people some ways to think about parent issues. I wrote an article for *Educational Leadership* with a principal of one of the schools that has used *Mathematics in Context*, documenting the kinds of parent concerns that came up there, and the kinds of responses that were appropriate.[5] The other article that I really think is a must-read is Alfie Kohn's *Phi Delta Kappan* article, "Only for My Kid," that provides some perspective on parent concerns.[6]

Implementing MiC

We've seen all sorts of different ways to implement *Mathematics in Context*, everything from the entire district starting all grade levels in the same year, to implementing much more gradually. In gradual implementation, districts often start with, for example, grade 6 the first year, the next year add on grade 7, and the following year grade 8. However the district decides to implement the curriculum, I think that realistically they have to look at least three years down the road before they're going to have any real sense of what's working, and what the results are for children. Now, sometimes districts get a big bang right away and can see real, tangible evidence of the effectiveness of the curriculum even within the first year. We've seen that happen. But more realistically, in order to successfully make the kinds of changes that these new curricula require, districts have got to take a long view of implementation. The long view is, I think, a minimum of three years for seeing significant change. And that might be a conservative estimate. ■

5 Meyer, M., Delagardelle, M., and Middleton, J. (1996). "Addressing Parent Concerns Over Curriculum Reform." *Educational Leadership*, 53(7), 54-57.

6 Kohn, A. (1998). "Only for My Kid: How Privileged Parents Undermine School Reform." *Phi Delta Kappan*, 79 (8), 569–577.

ERIC (RICO) GUTSTEIN ▸ TEACHER, GRADE 7

Background

In my opinion, the Chicago Public Schools (CPS) lead the nation in using high-stakes standardized tests to drive everything—kids, teachers, principals, and whole schools are evaluated on the results of standardized tests. Test scores have an overpowering impact on everything that happens in the system. And of course, they influence what individual teachers do in the classroom. It's more than a little chilling; it's a real sharp guillotine hanging over the neck. So, anything that happens in CPS has to be understood in that context. I don't think that can be appreciated from outside CPS. I think you have to live with it; I didn't understand it until I'd actually been in this building every day for the last three years. Given that, it's actually pretty amazing that anybody's willing to try a new kind of mathematics program here.

Rivera is, relatively speaking, more open-minded than many schools. The Rivera School's vision is a humanistic one that seeks to educate the whole child. People in the school community participated in developing, and more or less embraced, this vision—with different interpretations and understandings of what that means, of course. In general, there is less emphasis on drill and skill at Rivera than in a lot of schools in Chicago. Some teachers are still very much oriented toward teaching to the tests. Others believe that, for example, *Mathematics in Context* (MiC) is a powerful curriculum that will benefit students more broadly than just the scope of these tests, and they're committed to teaching the MiC curriculum.

Goals for students

The larger goal I have in teaching is for students to be able to use mathematics as a tool to read and understand their world. I want them to be able to use mathematics as a lens through which they look at social phenomena around them. For example, I want them to be able to evaluate advertisements for their fairness in representing data. I want them to be able to analyze SAT scores by race and social class to try to understand their significance in the larger context of what's happening in the world. I want them to be able to understand maps and to understand, for example, the difference between the Peters' projection and the Mercator projection.[1]

Getting started with MiC

I was a graduate student at the University of Wisconsin when *Mathematics in Context* was being developed. I never was a part of the official team but I was very excited about it. Initially, MiC was exciting to me because it was very strong in using real-life contexts. The developers believed that all mathematics comes from the real world, and they tried to design engaging and relevant contexts for students.

I am on the mathematics education faculty at DePaul University. When I moved back to Chicago, I contacted the principal of Rivera, whom I knew previously, and asked if I could come and work at her school. I started at Rivera in the fall of '94, working with the math teachers after school. We offered professional development on MiC and, more generally, on the NCTM *Standards* and what they meant. I pre-

Rico Gutstein teaches at the Rivera School, a Chicago public school located in a Mexican immigrant community, and is on the faculty at DePaul University. The Rivera School has about 725 students, 99% of whom are Latino and largely of Mexican and Mexican-American descent. About half of the students are immigrants themselves; the other half are the first generation in their family to be born in the U.S. Students come from low-income and working-class families, and 98.5% of them are eligible for free lunch. The community has a history of fighting for democratic rights, and has very strong community organizations.

The Rivera School is a neighborhood middle school, grades 6–8. Half of the students are in a monolingual English program while the other half are in a bilingual program. About 10 years ago, the community fought for a gifted bilingual program, resulting in an additional classroom at each grade. Students in the bilingual program are in self-contained classrooms for all major academic subjects but are integrated with other students for extracurricular activities.

Rico has taught in all three programs at this school: the 7th-grade bilingual program, the 7th-grade monolingual English program, and the 7th- and 8th-grade bilingual gifted program. He has used *Mathematics in Context* within all three programs. He now teaches in the 7th-grade English program.

[1] The Peters map projection is an equal area projection and the Mercator projection is the traditional map projection.

MiC is very strong in terms of the contexts that support the learning experiences for students. All the math comes from the real world and that's very powerful.

sented the *Mathematics in Context* (MiC) materials to the teachers. We talked about the materials, and people started trying some of them. I co-taught with teachers, we tried stuff in the classroom together, and we planned together. I also worked with kids in the classroom.

That continued for about two and a half years. Nearing the end of that period, I had been doing collaborative research at the school with other colleagues at DePaul. I had worked fairly intensively with one class of 7th graders in the bilingual program and with their teacher. So, I took over a class for a quarter in the spring of '97; that was the first time I had full responsibility for a class in a Chicago public school using MiC. Then, the next year, I had my own class and just taught that one class at Rivera. I taught one class for about a third of the year and then I shifted to another class in the 7th-grade bilingual gifted program. When they became 8th graders, I moved up to the 8th grade with them as their math teacher and have stayed with them. I currently teach a 7th-grade math class in the general (monolingual English) program.

Strengths of the program

MiC is very strong in terms of the contexts that support the learning experiences for students. All the math comes from the real world and that's very powerful. MiC tries to make the contexts engaging for students, but there are cultural and social class constraints and other constraints that make the contexts not necessarily so engaging or relevant to all students at all times. But, what is important is that MiC allows people to develop and use their own strategies to solve the problems that they are trying to make sense of. For the most part, I find that the curriculum works well for me. The units are tightly connected and the curriculum revisits ideas that people have touched on in the beginning of the year, which deepens their understanding of the material.

MiC does a very good job with data and algebraic reasoning. Some units do an excellent job of developing symbols and the use of variables. I think the development of linear relationships in *Math in Context* is also a particular strength. You can trace the development from the 5th grade through the 8th grade by looking at the algebra units. In my Teaching and Learning Elementary Math courses at DePaul University, I spend one three-hour class doing exactly that—tracing the development of linear relations in *Math in Context* in grades 5 through 8. Doing this, you can see the increasing levels of sophistication that are powerfully built on students' informal mathematical knowledge. At the end, for the first time in their lives, people understand the symbolic manipulations they were taught years ago. It's a profound experience and I think that's a real strength of the curriculum.

Making connections to students' lives

The traditional curriculum teaches kids to decontextualize and compartmentalize everything in their lives. They walk around carrying discrete, fragmented pieces of knowledge. Now we're asking students to contextualize and connect their experiences, to read the world and make sense of it at the same time. For example, I ask students to use math to look at the prices of real estate in different communities and to look at the racial composition of those communities. Then we ask important questions, such as, "Is racism a factor? Why or why not? What's going on?" When you ask kids to do that kind of synthesizing, you're asking them to counter the type of fragmentation and compartmentalization that they've learned in school and to make connections. They are learning to use math as a tool to make sense out of their world.

Mathematics in Context, which draws mathematical lessons from the real world, gives students an entry point to understanding important issues. For example, there's a nice 7th-grade algebra unit that is set in an urban planning debate between groups advocating different-density housing. Students have to develop, graph, and compare feasible plans using a variety of constraints. The lessons are not necessarily the same as the students' real-world experiences, since they are members of a particular social class, culture, ethnicity, and language group. But the ideas become concrete when we look at things like the increase in the Latino community in the Chicago area and we talk about the political and social implications of such a change in population. Looking at the data, they have to analyze it and draw meaning from it and then they have to write about the implications. The lessons don't mean anything until we connect them to their lives.

I sometimes use the important mathematical ideas in the curriculum, but I will find different contexts that, for one reason or another, I might think are more engaging to my students. For example, when we studied scatter plots, we also looked at SAT data. We analyzed the data by race and by social class, correlating scores with income level, and then used the information to create scatter plots. Now this project relates to who my kids are. Kids everywhere can see themselves in those data, but my kids are all at the bottom. I wanted them to look at the data and say, "What is going on here?" We were all trying to make sense out of those data.

Reading, writing, and classroom discourse

MiC is reading- and writing-intensive. In class, sometimes we read out loud, or have people work in pairs or groups. I ask students to write in their journals about their understanding, or write about what they learned on projects. I emphasize a lot of writing because I feel that one of the ways kids become more literate is by doing a lot of writing. They have to write in their journals every week, and they have to do writing for projects. We have one or two small projects a month where students have to complete a writing component. For example, they might write letters to Educational Testing Service sharing the data they collected and analyzed about SAT scores. The students have to do a lot of reading and writing.

I usually have kids either work in pairs or in small groups on the curriculum. Despite the fact that their verbal English is better than their written English, it's been hard for me to get students to communicate their thinking about mathematics in the classroom. One issue a lot of Mexican adults in this building talk about is the respect for teachers in Mexican households. In talking with Mexican adults, and specifically parents, I know that parents are fairly explicit with their kids that the teacher is to be respected. A mother of one of my students said, "It's not that we tell them not to listen to their peers, it's just that we tell them to really listen to the teacher because he's the one who knows." Because of this orientation among some families (and I don't want to generalize because it's not my culture), teachers are seen as a source of knowledge—not to be argued with, not to be questioned, and only to be listened to. I think there's a relationship between that and how students look at themselves, as well as their peers, as producers of knowledge. I believe that's one of the factors that has made it difficult to create mathematical discourse communities at the school. However, in small cooperative group settings, I find that the students are much more forthcoming than in a whole group discussion. There are issues here that I don't understand and the classroom discourse piece is still a challenge for me.

Looking at the data, they have to analyze it and draw meaning from it and then they have to write about the implications. The lessons don't mean anything until we connect them to their lives.

…the teacher's manuals help me to think through my mathematical goals for the class and look more deeply at how to achieve them.

Impact of MiC on students

As a result of the MiC curriculum, the ability of my students to generate written explanations has improved a lot. Remembering that these students are all second language English learners, their written explanations are pretty good overall when they are pushed to be careful and thoughtful, and they take that seriously. Particularly in a test situation that's graded, the students tend to produce high-quality written explanations for their work. So that's one thing that's working well.

I think the general mathematical sophistication of my students is also improving. In fact, my 8th graders are almost as good, in terms of searching for patterns, being able to make predictions, testing things out, looking at relationships, and doing some of these open-ended problems, as are the undergraduate and graduate students I teach at DePaul University. So I think that has to be attributed in part to the curriculum because it constantly asks students to justify their reasoning and think about things like that.

Challenges for teachers

Getting through the curriculum is difficult in terms of timing—nobody gets through 10 units, which is the ideal for a year. Kids often get bogged down at the end of a unit because they want to get done with the unit and move on to something else. They always like to plunge into a new unit, but by the time we've slogged through a unit for three or four weeks, they want to move on. I worry that sometimes I may not be doing enough to help students grasp sufficiently the increasing sophistication of ideas in a unit. It feels like just repetition to them when it's not. So one challenge is summarizing to draw out the big ideas.

In our school, there is a range among the mathematical knowledge of the teachers. There are some people who are teaching at the elementary level who have very limited math knowledge, but there is also a teacher who's an engineer who has a very strong knowledge of mathematics. Clearly for the people who have underdeveloped mathematical knowledge, they need to use the teacher's manual much more intensively. It can be a struggle to get them to use the manuals properly, but when you can get them to use them, they are very useful.

Part of the professional development I did with a 5th-grade teacher a couple of years ago was to do math together. This teacher was teaching a 5th-grade unit on percents and the number strand and she didn't understand percents. So we did math together for a couple of hours every other week. That's what she needed and that's what we did.

Teacher materials

The MiC teacher's manuals are very good. The teacher materials are very explicit about the different levels of mathematical goals that are covered in each section of a unit. These goals serve as a good guide for me as a teacher. I will read the goals for a particular section and try to understand them in terms of what I know. They're quite useful, and I usually see things that I hadn't thought of before I read the teacher's guide. For the most part, I understand the mathematics, but I'm not as experienced with scatter plots and histograms and such because my own training missed that. So the teacher's manuals help me to think through my mathematical goals for the class and look more deeply at how to achieve them.

I've even had students use the teacher's manuals to evaluate themselves. For example, on a project at the end of a data unit, I gave students a copy of all of the goals directly from the MiC teacher's manual, and asked them to evaluate how well they felt they understood each of these goals. I asked the students to write about the goals they felt they did not understand. Then, I asked them to take two goals and explain them in detail, giving concrete examples from the work they had done to demonstrate how they understood these particular goals. I thought that was very useful.

Sometimes, by the end of a unit, I struggle with helping students adequately draw out the big ideas and what the unit is about. There are increasingly sophisticated ideas that perhaps I do not help students grasp sufficiently, and so it may feel repetitive or finished to them even though there is more to learn. I want to ask, "So what? What's really going on? What's the meaning here? Why is it important?" The support materials for teachers help me to make those connections tight.

There are also supplemental resources such as the *Number Tools* books, which give kids more explicit practice. *Number Tools* is a general-purpose tool for students that is integrated in many of the units and gives students extra practice in important areas.

Adapting the curriculum

I occasionally use materials that are not part of MiC. For example, I've used some 9th- or 10th-grade problems from IMP (*Interactive Mathematics Program*). I like the famous locker problem.[2] Kids get very engaged in those types of open-ended, extended problems that take a number of days because they get to work and invent and create their own ideas. We might spend three, four, or five periods on a problem and then students get a chance to share their ideas using the overhead. Sometimes my students really like to do these types of fun, totally irrelevant, fantasy situations that are very challenging and intellectually stimulating. For the most part, MiC is not like that and focuses on real-world contexts, so occasionally I like to supplement it with other materials.

To know what's engaging for kids is really complicated. As a teacher you face the quandary of figuring out what you need to do. We cannot take the position that it will all turn out in the end or if we teach them good math they'll do fine on the test. It's just not that simple. Certainly MiC can't take responsibility for that because it was not designed so kids could pass timed, multiple-choice tests. That's not the intention and it shouldn't be the intention. But we have some very cold realities to deal with. I have students who are 8th-grade dropouts and pregnant and on the streets and in gangs and dead. How do you deal with that? A curriculum alone will not solve all of our problems. I'm more concerned with what it is that you can do to get students to think about things differently. And that's been an ongoing process and struggle. By supplementing with other things outside of MiC, I can include these ongoing projects in which students can practice making sense out of the world and using mathematics in a useful way. I think MiC is necessary, but not sufficient, to help prepare kids to be critically literate in terms of thinking about the world and using math as a tool to understand and change their world. But I do still face the question of how to balance all of the things we as teachers need to do—preparing

[2] The locker problem is about a corridor with 100 lockers. One student comes along and opens all the locker doors, and then a second comes by and closes every other one. A third student walks down the corridor, and starting with locker #3, changes the state of every third locker—closing the ones that are open and opening the ones that are closed. The next student who comes along changes every fourth locker, beginning with locker #4, and so on. The task is to figure out which lockers are open after the 100th student comes by.

I do still face the question of how to balance all of the things we as teachers need to do—preparing students for the tests, teaching them good mathematics, and developing their reasoning abilities.

students for the tests, teaching them good mathematics, and developing their reasoning abilities. How do you really do all of these things and make sure the students pass those high-stakes tests? That's still a quandary for me.

Alignment with standardized tests

The Iowa test that CPS students take in grades K–8 is very broad—a mile wide, and an inch deep. So there are lots of content areas covered on the test. Teachers perceive that they're not covering the material they need to to prepare kids for the Iowa because, in fact, they're not. Either by virtue of the fact that the Iowas are a mile wide or because they emphasize symbolic things that aren't necessarily in MiC or because of whatever concrete experiences that take place in students' lives and school, teachers are not able to "cover" all the stuff. Now the converse of that is that the type of thinking experiences kids gain from successfully encountering the ideas in MiC prepares them to bring their brains in the door to deal with the Iowa tests. But of course timed tests are not brain-friendly—they're more procedure-friendly. If we ask students in MiC classrooms to think deeply about the ideas, to compare multiple ways of doing things, to look at an idea from multiple perspectives, to reflect on it, to think about connections, etc., and then we put them in a testing situation which is antithetical to that, then at some level, the curriculum does not prepare them for those tests. You can also argue that it does prepare them for the tests in that it encourages students to think more broadly. But there are pluses and minuses in terms of this issue of alignment.

MiC has done some work comparing traditional 8th- or 9th-grade introductory algebra texts with MiC. They took a traditional text and went through chapter by chapter, looking at every one of the top mathematical topics, comparing it to those covered in MiC. The topics that are not covered or are deemphasized in MiC are those which the NCTM *Standards* have recommended paying less attention to—for example, factoring or algebraic fractions.

Test preparation

Preparing students for standardized tests is a struggle. There have been times when I have done things that go against my grain. For example, a number of my kids applied to academic high schools where they had to take tests that are essentially standardized tests. I met with kids and tutored them after school and we went through rote procedures. It's very clear that this is not what we do in class—this is about helping you do well on this test. One way I deal with that is I put these issues out on the table. I mean, students are very clear that what we do in class is different from what they might do in a traditional high school or what they might need to do on the test.

So one way of trying to deal with that is to be up-front. Sometimes I say, "This is Iowa preparation." I will explicitly prepare them for symbolic stuff in class. Because, one, if they don't pass their Iowa tests, they don't graduate. But, two, it's important because my work as a teacher there will be evaluated in part by how my kids do on the standardized test. And if I want to continue doing the work that I'm doing, I have to produce certain kinds of results also. The good thing is, I can level with my kids about that. I try to make it very clear to them that this test has very little to do with who they are as people and that the score in no way measures their intelligence. ■

CARMEN KEYS ▸ MATHEMATICS TEACHER, GRADE 8

Carmen Keys is in her third year of teaching 8th-grade mathematics at Plainview Rover High School, in a K–12 district of about 300 students in Plainview, Arkansas. Plainview is a poor, rural, logging town. The student population is almost entirely Caucasian, and over 50 % of the students receive free lunches. Because the district is so small, Carmen teaches 8th grade, 9th-grade Algebra, 10th-grade Geometry, 11th-grade Geometry, and Advanced Math. In 1998, the school received a middle-school mathematics grant and adopted *Mathematics in Context* for grades 5 through 8. Carmen was interviewed during the first year of the *Mathematics in Context* implementation in Plainview. The district recently adopted *Everyday Mathematics* for the elementary grades, and *SIMMS Integrated Mathematics* at the high school level.

Choosing *Mathematics in Context*

The principal at our school gave the 6th-, 7th-, and 8th-grade teachers a list of the five NSF-funded middle-school programs and let us choose the one that was best for us. We reviewed the materials that we could get for each program, and we chose *Mathematics in Context* (MiC) because of its integrated approach. We liked the problems because they were real-world problems that helped students learn and develop their own problem-solving strategies. Also, there was so much writing involved and that's exactly what we were looking for in a new program.

Because we had a grant last year for middle-school math, we adopted MiC and jumped right in. We put all four classes—grades 5 through 8—in at the same time. This is almost the end of the first year and it's going great; we really love it. My administrator says that, had we been able to, we would have started with the 5th and 6th grades and just moved up year by year. But because of the way the grant was written, if we didn't use all of the money, we'd lose it. So we pretty much had to jump in with all four feet. It's been tough for the 8th graders. But that's what we did, and it's worked.

I really love the program so far. It will be a lot more interesting in four years when I get some of the kids who are now starting the program at the 5th grade. I'm really anxious to see what happens when the 5th graders who started it this year end up in the 8th grade with me. I hope it's going to work as well as I think it is. We took the end-of-level 8th-grade test this year and I'm also anxious to get the results on that. I think change even within this first year is possible. I really think it's possible.

Strengths of *Mathematics in Context*

What's working really well for me with *Mathematics in Context* is that the students are getting a better understanding of the mathematics they're learning because they're not just learning rules, they're discovering things. I don't just stand up in front of the room and tell them, "You do it this way because that's how we've always done it." Instead, they're discovering properties. For example, one of the very first things we did in the classroom was discover a calculus concept about limits. In the book there was an activity where the students fold a piece of paper and they keep folding it in half and taking halves of it until they finally realize it could never get to zero. In 8th grade, my students were discovering calculus concepts.

I'm just thrilled with the algebra strand in *Mathematics in Context* and how the program presents equations. One of the first things students work with is "next-current" formulas: they look at a pattern of numbers and from the current number, the question is "How do you get the next number?" The program goes from these informal equations into the regular algebraic equations that the kids are used to seeing. It helps the kids to actually see what the numbers in an equation mean, that the constant is where the pattern starts or where the graph hits the y-axis. They actually see these things and experience them and discover ideas on their own first, rather than me just telling them what that number means. Then we can talk about the pattern as a rule. All the way down in 5th grade, MiC starts out with algebra and does things that just amaze me. It's not anything our 5th graders have seen before, I'm sure. The probability strand in *Mathematics in Context* has been great, and the geometry strand also has been great. Since the students are not learning formulas but are experimenting with and experiencing mathematics, I think they're going to remember it a lot longer. It's not just memorization—they're coming up with these ideas themselves.

Instructional approach

With MiC, I started putting my students in groups. The program lends itself real well to groups where the students can discuss their work. I'm more of a facilitator than a teacher—I walk around, and I get in on the discussions as I walk around, while the students are talking about problems. We come up with solutions as a group in that way, rather than me standing at the board and giving examples. We started off the first of the year with groups and it just seemed to work for us. There's always one or two kids that I have trouble getting fully engaged into the group but we usually don't have much of a problem getting whole-group conversation started. That's probably because my school is so small and everybody knows everybody. Also, I know that students are involved in a lot of discussions in science. They also work in groups in science quite a bit, or have before, so that's probably why they're so good at it now.

Most students really seem to enjoy the approach in *Mathematics in Context* and they like the new activities because they get to do so much hands-on work, cutting out paper, working with triangles, and things that they hadn't done in a regular math classroom before. Almost all the problems in MiC involve something that you run off on a copier and students can cut out. One of the things we did recently was learn about similar triangles. We had a triangle puzzle that they had to cut out with scissors and then put together, and the activity helped my students to see where the similar triangles were and how they fit together. Everything in the program is like that; you cut it out or make it with something that's handy. One activity had spaghetti in it, and students break spaghetti off into certain lengths and form them together to make triangles. The materials are not that expensive; the most expensive cost has probably been paper, which has not been a problem for our school district.

Changes for students

The biggest challenge for us has been the writing. Our students are not familiar with writing in mathematics, so that's one of the things that's been hard for our students to adjust to in MiC. In the past, I never taught kids how to articulate mathematical ideas and explain what they've done in a problem. That's what my students are doing here with MiC. I don't grade on spelling because I want my students to develop their articulation skills—just trying to write something down—and I think that's going to help them later on.

One problem I've found using the program is that, with the kids who have trouble reading, I really have to go to them and help them read. That's been hard, but about all I can do is go work with them in their groups and help them read through without making it as obvious that they're having a problem with the reading.

Some students are finding *Mathematics in Context* to be a drastic change. I'm a brand new teacher for my class, so the students seem to accept the changes pretty well because they knew that I was going to be new and things were going to be different. But for our 7th-grade teacher who taught her students before in 6th grade, the students didn't expect such a change, and she's encountered more of a block where they don't want to do this new math. I think my class would have, too, if I had taught them last year. I don't think it was anything on her part, I just think mine expected, "Oh, we're getting a brand new teacher." The others were not expecting anything so drastic, because it was a definite drastic change for our school.

Many of the kids who are doing well in the program are the ones who did not do so well in a traditional math program. Often, the students who struggle now are the ones who used to be the top-level kids because they would much rather have 30 straight problems that they can zip through and be done with. They're not used to thinking; they'd just rather be told how to do it. However, I do have one student who was at the top of her class before and she tells me every week that she likes MiC much better now because she would rather understand why something works than to have me tell her how to do a problem. As a teacher, it feels so good to have a child in the class who really wants to understand why.

Changes for teachers

Since this is my first year using this program, a lot of times I have to read ahead. Occasionally, when I'm not sure where the lesson is leading, I'll look ahead to find that out. There are teacher notes, but mostly I look ahead in the unit. It flows so well that it is not hard to find my way through it. Sometimes, the book tells us a lesson will take two weeks, and then it usually takes us three. I think that will get better as I go along and get used to the material.

As I've talked to other teachers about this program, many of them were concerned that the way of teaching was so new and that the grading system was so different. I have heard a lot of teachers who said they were not interested in changing their way of teaching. The change was definitely drastic for our teachers, especially in the grading. No longer can we go through and pick out the right answers. At least every fourth question requires a paragraph-long answer that must be graded on a rubric scale, so there's just a lot more grading. For now, I'm still bogged down in grading student work. I haven't yet figured out a good way to deal with it but I'm still working on that.

I like the material and I can see where it's going, and I think it's great. I hope it's going to work as well as I think it is. There are a few teachers in our district who are struggling with the program. I think part of the reason is because I've bought into the philosophy and others haven't. They're waiting and they want the students to understand everything about fractions before they move on. These teachers are moving a lot more slowly in their book. To be honest, our lower-grade-level teachers are finding it a lot more difficult. They teach in a classroom setting all day long, they teach science, history, math, English, everything. They're not math specialists.

One recommendation I have for someone about to use this program is to definitely work through the book before you teach it. The only way you can understand what the students are doing and where they are going to have problems is by going through it yourself. Other than that, our teachers pretty much follow the basic guidelines from the company that publishes MiC for how to set up the course and which units to teach first. That's worked okay. As I get used to the curriculum and the various books in the program, I'll probably modify them. Maybe next year I will have more time to plan in depth and think about changing things around. For now, I just tend to work through the problems and decide what's the most important problem, what we need to discuss in class, what I can send home for homework. The guidelines in the implementation guide are very thorough and tell you which books need to go first and which skills they have to have before they can do a certain book.

The change was definitely drastic for our teachers, especially in the grading.

The guidelines in the implementation guide are very thorough and tell you which books need to go first and which skills they have to have before they can do a certain book.

Nobody's saying, "I wish I had better teacher support material." I haven't heard that complaint. The biggest complaint I've heard is that the program does not have enough skills work. I've found some worksheets from other books and pulled in things like that. The program could use more materials to use and send home for skill practice.

Professional development

Five teachers in our school district are using MiC. Three of us went to Delaware for a week-long training workshop, and then we came back and shared what we learned with the other two teachers. We basically worked through the problems with them and showed them what we had done at the training, and then we talked about how we will use the materials. In the MiC books, there's not a lot of practice material so we talked about how we were going to deal with that. We decided we were going to pull some worksheets from our own materials that students could take home to practice skills. We also talked about what the assessment would look like. There are assessments in the back of the book that I've used quite a bit. Some of the other teachers are not as comfortable with the assessments because they are more open-ended assessments than we've used in the past.

Being a small district, we all have different planning times, so we've gotten together only four times this year. We planned a math family night together and spent a lot of time talking about it. But, overall, there's not a lot of communication, so we don't get a lot of feedback from each other. We just don't have the faculty to cover our classes.

Administrator support

Our administration has been very supportive. As a matter of fact, our principal is helping me to change our high school curriculum. We're going towards an integrated program as well, and the administration has been very supportive of a new approach. I suppose the principal's philosophy is pretty much the same as mine—if the "same old same old" isn't working, then you don't do the same thing.

Working with parents

We got some negative feedback from parents initially. Because *Mathematics in Context* is packaged as modules, and not workbooks, we weren't letting students take them home, and that was a big, big problem. So we changed that and now we let our books go home and we don't have as much of a problem. There are still some parents who have complained that they don't understand the work themselves. We're in a very rural district, and very few of our parents have even finished high school. I had a math night when we started having some problems. I'm the lead teacher at the school, so I decided to hold a math night to try to get some parents there to discuss the program and answer some of their questions and talk to them about their concerns. I had only one parent show up and that was discouraging to me. Last month, we received a grant for another math night. We advertised more and spent more money on it. All five teachers got together and planned an activity to invite our parents to work on, but still participation was very limited.

Most of the rumblings we heard came in the beginning of the year. Now we're not hearing as many complaints. I have also heard several positive comments. As a matter of fact, one of the parents in my class came to me and told me she had never seen her daughter so excited about her math class. She comes home and talks about math problems all the time.

State testing

The state test is called the ACTAAP test[1], and, at the time we made our curriculum selection, it was a test that only our 11th graders took. The test has one section of math that is composed of multiple-choice questions, and another section of that is composed of open-ended questions. In this second section, the students have to explain what they are thinking. Our students were not used to expressing their thinking in that way, so we were trying to find a program that would give them the proper training.

Now, the ACTAAP test has been changed to 8th grade, and then students also take end-of-level algebra and geometry tests. These tests have open-ended questions. *Mathematics in Context* just seems to be aligned with our tests much better than the program we were using before.

On the 11th-grade ACTAAP, there was a problem concerning distance, time, and the formula for distance. This problem was brought up at a statewide meeting of math people, and they talked about how this particular problem on the ACTAAP had an average score of zero, which means most of the people did not respond to the question. I gave the exact same problem to my 8th-grade class and scored them on it. The average score was a three out of five. I was really impressed with that, because the average 11th-grade student, especially from our school, didn't even bother to write anything down because they didn't have a clue as to what to write and our 8th-grade MiC students were at least willing to put down something.

Addressing different learning styles

I don't think the *Mathematics in Context* materials address different learning styles as much as they need to, and that's been a problem for me. I've basically been on my own modifying and adjusting problems to meet my own needs. For example, I have one student who can't learn by listening, so I've had to draw pictures for him. Another example is a problem we just did that had a dot diagram of polyhedrons. Students are supposed to count the dots and to think about the number of faces and vertices a shape has. They could count the dots without problem, but where the dots represented the vertices, they couldn't count the number of faces or sides. They couldn't look at the dots and imagine what these shapes would look like. It wasn't until I pulled out other materials and showed them what they actually looked like that they understood. This problem was about two-dimensional representations of three-dimensional objects, and it was tough. This came up during an algebra lesson, which may be why the students ignored the visual perception. There have been other instances like that, but not many. ■

…one of the parents in my class came to me and told me she had never seen her daughter so excited about her math class.

[1] ACTAAP stands for the Arkansas Comprehensive Testing, Accountability and Assessment Program. The test is criterion-referenced.

LOUISE TEAF ▸ SUBJECT SUPPORT SPECIALIST, MATHEMATICS

Louise Teaf is a Teacher on Special Assignment for the Red Clay Consolidated School District, an urban district in Wilmington, Delaware. The district is the second-largest district in the state. There are about 1200 teachers and about 16,000 students from various socioeconomic and ethnic backgrounds in the district. Red Clay has a bilingual program and the minority population is around 35%. The Red Clay district is using the *Investigations* curriculum at the elementary level, MiC in the middle grades, and some *Core-Plus* at the high-school level.

Louise is in her third year as a Subject Support Specialist in mathematics for grades K–12. She works with six middle schools. Prior to that she was a classroom teacher for 21 years at the elementary and middle grades.

Why *Mathematics in Context*?

When I first came into this position, there were some seminars offered by the University of Delaware to raise awareness about exemplary standards-based curricula at the elementary, middle, and high-school levels. Knowing there was a need for reform in our district, I attended the seminars, looked at materials, and listened to presentations regarding the NSF-funded mathematics curricula at all those levels. From these seminars, I really liked the *Mathematics in Context* program. I had some connections with a math educator at the University of Delaware, Dr. Jon Manon, who had used some MiC units with selected teachers in different schools throughout the county but not in Red Clay. Through Dr. Manon's recommendations, seeing the program used in classrooms, and the seminars at the university, I felt that MiC was one of the curricula that I would like to see used in the district. What I liked about *Mathematics in Context* is that it is a very rigorous curriculum that meets the needs of diverse students. There are a lot of extensions, and there's a lot of enrichment to meet the needs of the gifted child. But I also feel that, given the presentation of the concepts and the way concepts are introduced and built in the units, even children who struggle with mathematics can be very successful and feel good about themselves as developing mathematical thinkers.

In the past, we used the Glencoe mathematics series at the middle grades and a Harcourt series called *Mathematics Plus* in the elementary schools. They were very traditional programs—children just had to respond with an answer to an algorithmic-type problem—and there was very little opportunity for thinking or deep understanding. Students had to memorize facts and then they were asked to simply regurgitate the facts and the processes so either they had the skills or they didn't. But if they didn't memorize facts or didn't know the process, there was no opportunity for them to try to get an answer. *Mathematics in Context* gives children opportunities to use different processes and procedures. It teaches them various ways to think about things. They can then use what they understand and build upon that. They have enough skills and tools so that they can solve the problem that's presented to them. So, there's a way of access for everybody.

Strengths of *Mathematics in Context*

The developers of MiC wrote the lessons keeping in mind the way children think. They worked with a lot of children through field tests and they have an understanding of how children learn mathematics. The units introduce topics that appeal to children. For example, in 5th grade, in one of the first units, *Patterns and Symbols*, they start to look at patterns. Mr. Miyagi from *The Karate Kid* asks kids to draw a line in the middle of the floor of a karate room. Students are asked, "First of all, are there the same number of students on the lefthand side as the righthand side? Tell us a little bit about the students on the lefthand side. Is that an odd number or an even number? Well, if we added another student on the righthand side, would the classroom have an even number of students?" The graphics in the curriculum are very good. The pictures at the beginning of the lessons are ones that you would see in life, and that piques children's interest.

One of my teachers started a rigorous 8th-grade unit on vectors. She started the unit thinking, "These concepts are immature. Everybody is going to think this is stupid." But after she went past the first three pages, she said the unit moved into some very sophisticated math. MiC managed to take a difficult concept, break it down into component parts, and make it very simple, letting kids buy in from the beginning. Then all of a sudden, they were into very complex mathematics.

I like the way MiC develops the units, how they focus on topics that students are interested in, and how they take these ideas and mathematical concepts and develop them to the fullest degree. There are a lot of interconnections within the curriculum. And I think that the presentation of the material is very different than some of the other NSF projects. I just feel it's got more of a unified theme, whereas other programs might try to bridge a traditional approach with a format that looks more like a regular textbook. In *Mathematics in Context*, the children are put through a process of thinking through ideas that are unified by themes. It's a really tight package.

Algebra

What I like most about *Mathematics in Context* is the rigor and the diversity. The rigor in the algebra strand is really one of the strengths of this program. We still offer the Algebra I track in the 8th grade for the parents of children who don't entirely buy in to the approaches of the new program. But when our 8th-grade teachers try to teach an algebraic concept, they find that the children have no understanding or aren't able to perform on an assessment. So they will use *Math in Context* units to bridge this gap of understanding. We found that once the children had a knowledge of what was happening or an understanding of the process, they could then use the symbol manipulation to solve the algebraic function. But without first having an understanding of what they were supposed to do, it was very difficult for them to do the math.

The algebraic concepts are built right through the whole curriculum and are related to each other. When ideas are reintroduced, they refer back to the prior problem and that lets the children recall the context and the math. The algebraic concepts are thus developed over the long term. For example, in one of the 5th-grade units, *Patterns and Symbols*, students are introduced to the V patterns of flying birds. The pattern is always two geese (n) plus the lead goose (1). So it's $n + 1$. When students work through this in the 8th grade, they're introduced to double V patterns, which would be $2n + 1$. And so when they talk about the double V pattern of the geese flying, right away the students can connect that to the previous experience they had in the 5th grade with the same subject. So in the 5th grade, students focus on understanding this pattern of always adding 2, and in the 8th grade, they learn an expression that characterizes the general case. But they can tie the ideas together and make the connection because the theme is carried through the grade levels. The program builds layers and layers of different and increasingly more complex ways of thinking about issues.

Staff development

Encyclopedia Britannica provided staff development on-site for our teachers. That's crucial, because without staff development, it's very hard to implement one of these programs. Initially we put our teachers through a one-week training session, but that really was not enough. The first year's real tough; teachers need to go through each lesson prior to teaching it. If they don't do that, they're in trouble. They have a hard time presenting the information and they don't know how to guide children's thinking. It becomes very frustrating for the teachers if they aren't prepared.

We also offer sustained staff development. We hold quarterly meetings for teachers in the district who are using *Math in Context*. We choose a topic for the meeting, address the topic, and form our staff development around it. Teachers hear

I like the way MiC develops the units, how they focus on topics that students are interested in, and how they take these ideas and mathematical concepts and develop them to the fullest degree.

Anytime we do staff development, we really try to focus on, "What is the mathematics? Where does the mathematics concept start? And where do we end up in this unit?"

how other teachers are struggling with certain issues in their classroom, and how they resolve those issues. We also share test items. So these meetings are very helpful and everyone has something to gain. And that's really the idea.

For example, something that a lot of teachers struggle with in any of these programs is how to set up the class and manage cooperative groups in which students are responsible, can participate, and use time effectively. Early on in the year, we did some work looking at group work and how to set up cooperative groups.

We've also looked at proportional reasoning. We've looked at the ratio tables to see how they develop across grade levels. We've done some work in the algebra strand, seeing how that builds, and how it's introduced in the 6th grade, and how it's followed through in the 7th and 8th grades with exponential functions and linear equations.

Anytime we do staff development, we really try to focus on, "What is the mathematics? Where does the mathematics concept start? And where do we end up in this unit?" The first time that you teach any of the *Mathematics in Context* material, or go through these units, it is a very tough job. Even though the materials are there on the page, you might pass over something the first time you go through the unit. The second time, you learn so much more, and you become better.

For those who don't attend staff development or who don't use the program as they're supposed to, this program will definitely be a challenge. But if teachers do what they're supposed to do, and work through it, and attend the workshops, they learn so much. Unlike in the past, the staff development is critical now, because we are asking the teachers—even the good ones—to go to a different dimension.

Many teachers are thrilled. They say, "Oh my goodness, I never knew this. I've learned so much." People who aren't saying that are the ones who aren't taking the time to work through the unit, aren't taking the time to make it work, and would rather just pass out materials and take a passive teaching role or lecture. So there the fault lies not in the materials, but more in the way the people are approaching them.

Student learning with MiC

Most of my teachers love *Math in Context*. One 5th-grade teacher who uses *Math in Context* teaches a very low group but her children just thrive on this stuff. She taught it last year and she's teaching it again this year. Her students are able to perform. They can do computation because they invent different strategies, or they use different methods to be able to be successful and arrive at the correct answer. They're doing very sophisticated mathematics, because of the way the concepts have been described to them.

None of the students that I've seen dislike it. If they didn't start in 5th grade, they might have some feelings about it because nobody tells them the answer. They have to figure it out on their own working with their group to arrive at an answer. Many of my teachers are very good at making the students use the resources of their group rather than relying on the teacher. But until the students learn that process, they become frustrated, because they want to know what to do. They don't want to think the process out.

The level of reading required in MiC can be an issue for some students. But we talk about that and there are ways that we deal with that. For example, when we use a cooperative group, we try to make sure that the group is composed of members who have different strengths. And if reading is a problem, maybe one student in the group might read the selection, and we rotate the reading around the group.

The reading is not so great that it becomes a burden, and the words are carefully chosen so the children can use key words and pictures to figure it out. We even use the program in a special-education classroom where the teacher really wanted to use *Math in Context*. She reads some of the materials to the class, and does more direct instruction where she points out key words and helps the students become involved in it. She has great success with the curriculum.

Assessment and testing

The teachers had to become familiar with rubric-type assessments. This is a change, going from one right answer to having to read students' papers and know that there are different ways to solve problems. The teacher's guide is very good in guiding teachers through a lot of the different possible answers to questions. The assessment in MiC and the assessment activities that the teachers build follow along nicely with our state assessments, especially if you're looking at any of the problem-solving parts of the Stanford 9, or tests like that.

We are starting to get data back on the learning that's going on and it's very interesting. In the preliminary data that I have from the classes that we've been following carefully, we are seeing positive gains. We are seeing a narrowing of the gap between the high achievers and the low achievers. This is interesting because from everything people tell me, this isn't supposed to happen after one year. We're still finding gains, even where implementation has not been ideal.

Implementation

I recommend using *Mathematics in Context* as a full 5–8 curriculum. I think you can use it as a 6–8 curriculum, but I think, to do the best job for students, I'd use it in grades 5 through 8. MiC at 5th grade is a stepping stone to where students need to be in middle school. If you want your students to have a strong algebra background, then this will do it for you. The 5th grade in MiC is the beginning of all of those strands, so starting to use it at the 5th grade makes good sense.

If I had it to do over again, I would implement 5th grade first, and then add a grade level each year, phasing in the program. Here, we introduced the program at grades 5, 6, and 7, and then added 8 in the following year. There were a lot of issues that came up for both teachers and students. For example, there were concepts that students never had experience with in a traditional curriculum, such as data and statistics. With MiC, they are also being taught in ways that are different from what they're used to. So I think it's best to phase the program in to avoid some of the problems we encountered.

I would also encourage people to have a minimum of a week of staff development prior to starting. I would also encourage more than one—a team, if possible—of teachers to be using it, so that they can dialogue. The interaction between the teachers within the school is very important. We tried to create opportunities for teachers to talk among themselves. A nice benefit of this type of interaction is that teachers hear how other teachers struggled with certain things in the classroom, and how they resolved those issues. We also shared some test items, and things like that. And so it was very helpful to everybody, because everybody had something to gain. So that was really successful.

I find that in many of my schools where there was more than one teacher at a grade level using this program, it was very successful, because they had support from each other. I would also encourage meetings or in-service day sessions to be used

If I had it to do over again, I would implement 5th grade first, and then add a grade level each year, phasing in the program.

The parents found the curriculum very rigorous. They were amazed that their students could do these things.

to look at the next book, or the next units coming up, as a preparatory measure to make it through the first year. If you're doing a district-wide implementation, monthly or bimonthly meetings are really important for getting people together throughout the district, so they have another opportunity to share. I think that is the biggest thing we need to do.

Administrative support

The building administrators are supportive if there's been no parent objection. However, educating them about the curriculum is a must. We have made some videos. I've had a videographer in the classrooms, filming snippets from all levels, so that we can show the video to principals and discuss what to look for in good teaching. One of my middle-school teachers did a 40-minute video on a lesson from *Math in Context*. We're going to use it for staff development to model a lesson in a classroom setting: how to get kids working, how to launch the lesson—realizing that you don't just pass out the books without any instruction. That should be available this summer for our staff development purposes, and I think that's really important.

The assistant principal of one of our schools came to me and said that since they've been using MiC there, it has helped to reduce the number of discipline problems in the school. The school has a very high-SES (socioeconomic status) population and discipline is a problem in most classes because students aren't motivated to learn. There is little or no parental involvement in the learning process, other than parents telling their children to do their homework. So maintaining discipline and motivating students is very difficult. *Mathematics in Context* has engaged the students in the learning process and discipline has become less of an issue in the classroom as the students are engaged in the curriculum and not in misbehavior. This was a very important lesson for us.

I visited that particular school and observed students taking open-ended assessments, where they had to write and explain strategies. When the teacher passed out the assessment booklets, I was a little concerned because I thought this was a population of kids who would sit there and do nothing. But in this instance, as soon as the assessment books were passed out, students immediately began to read the questions, start to write down strategies, and solve them.

Educating parents

I did a parent night in two different schools, and put the parents through a simulation of some of the items from the MiC curriculum. I told them that they had to be students of that grade level, and that they could not use their algebra skills. Most of them have forgotten them anyhow.

The parents found the curriculum very rigorous. They were amazed that their students could do these things. When I first put them to task, they thought sharing their ideas was the same as cheating. I told them it wasn't and that they could talk amongst themselves, and they had a hard time dealing with that. So we talked about that a little bit and about the interaction between the students. To tell you the truth, the parents in the one school that I had most concern about liked the program after I did this presentation. Many of them work for DuPont or AstraZeneca (a pharmaceutical lab), and they realized that this is the kind of thing they have to do in their jobs. They need to discuss and understand problems that they face. So the parents left feeling confident that we were preparing students for the workforce by using this curriculum. ■