CONNECTED MATHEMATICS

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A middle school curriculum for grades 6–8, developed by the Connected Mathematics Project (CMP).

Connected Mathematics strives to develop student and teacher knowledge of mathematics that is rich in connections and deep in understanding and skill. *Connected Mathematics*' goals can be summarized into a single standard: all students should be able to reason and communicate proficiently in mathematics. This includes knowledge and skill in vocabulary use, forms of representation, materials, tools, techniques, and intellectual methods of the discipline of mathematics including the ability to define and solve problems with reason, insight, inventiveness and technical proficiency.

Connected Mathematics defines skill as much more than just proficiency with computation and symbol manipulation. Skill in *Connected Mathematics* means that a student can use the mathematical tools, resources, procedures, knowledge, and ways of thinking developed over time to make sense of new situations.

The curriculum is structured around "big ideas" in mathematics—clusters of important, related concepts, processes, ways of thinking, skills, and problem solving strategies. The curriculum emphasizes significant connections among various mathematical topics and to applications in other disciplines. These connections also offer opportunities to revisit and deepen understanding of mathematical ideas.

Mathematical concepts are embedded in the context of interesting problems—real applications, whimsical settings, or mathematical problem situations. As students explore a series of connected problems they develop skill and deep understandings of mathematical ideas. Problem content becomes a vehicle for understanding and remembering concepts. The curriculum develops six mathematical strands—number, geometry, measurement, probability, statistics, and algebra.

Connected Mathematics is organized into units that investigate important mathematical ideas. Each unit contains four to seven investigations; each investigation explores one to five major problems in class to develop students' understanding and reasoning. The problem-centered teaching model consists of three phases: launching the problem, exploring the problem, and summarizing the problem. Extensive problem sets, called Applications, Connections, and Extensions (ACE), help students practice, apply, connect, and extend these understandings. Investigations culminate in Mathematical Reflections, helping students articulate their understandings and connect "big" mathematical ideas and applications.

Connected Mathematics gives students many ways to demonstrate how they make sense of the mathematics in the units. The Assessment Resources include check-ups, partner quizzes, projects, unit tests, self-assessments, and question banks. *Connected Mathematics* also suggests that students keep notebooks and journals for mathematical reflections, vocabulary, assessment, and other class work.

Students need access to calculators at all times. In the 6th grade, students use a standard scientific calculator. In grades 7 and 8, students need access to a graphing calculator. Optional computer software programs are suggested to enhance some of the units.

Each grade consists of eight units. Student materials are available in softcover, nonconsumable modular form. A *Teacher Guide* accompanies each unit, and contains a discussion of the mathematics underlying the investigations within a unit and the instructional role of the teacher in orchestrating the classroom investigations. For each unit, the *Guide* gives a list of the materials needed, suggested timelines, homework assignment choices, and essential vocabulary. Teacher materials include blackline masters of consumable student pages and overhead transparencies.

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ELIZABETH PHILLIPS ▸ DEVELOPER

Elizabeth Difanis Phillips co-directed the *Connected Mathematics Project* (CMP), a five-year NSF-funded project to write, test, and implement a complete mathematics curriculum for the middle grades (1991–1997) and a teacher enhancement grant (1995–2000) to develop mathematics educators who can assume leadership roles in implementing *Standards*-based curricula nationwide. Currently, Ms. Phillips directs the CMP satellite for the Show-Me Center[1]. She is also a principal investigator of a new NSF grant to revise the CMP curriculum and develop professional development materials to accompany it.

Ms. Phillips has been a Senior Academic Specialist at Michigan State University in the Department of Mathematics since 1972, teaching mathematics and mathematics methods courses for elementary and secondary teachers. She has directed several teacher enhancement, curriculum development, and research grants in Mathematics Eduation at both the middle-school and high-school levels. She was the Chair and Editor of the MCTM monograph series from 1988–1990, and was a member of the Leading Mathematics Education into the 21st Century project in 1990. Ms. Phillips authored the book *Patterns and Functions for Middle Grades Teachers*, (NCTM, 1991) and has written many other papers and books.

The development of CMP

In the seventies, I was in charge of the remedial algebra course here at Michigan State. At that time, about a third of all freshmen were being placed in remedial algebra—even though they had already had 11 and 12 years of math. That percentage has not changed since then. At the same time, Glenda Lappan and Bill Fitzgerald were working with preservice elementary and middle-school teachers, and were realizing that teachers needed a lot more support in developing their understanding of mathematics. Together, we began to struggle with ways we could work with the K–12 system to try to make some changes.

One of the things we realized by looking at what happened to kids when they came to college—and these were fairly successful kids by some measures—is that they weren't making sense of mathematics. They were memorizing symbols that were nonsense to them. They had no vision that there were a few important ideas in mathematics around which other ideas clustered. I don't think many people talk about what's really important to understand. Early on, we felt that we needed to isolate a few key ideas and help students develop some in-depth understanding of those ideas, and begin to connect them.

Our curriculum work centered around some of these key ideas. Spatial visualization was a big area for us, because there was controversy at the time about whether or not women were good at math because of spatial visualization. Similarity was another key idea. We also looked at factors and multiples, number theory, and probability. We began to isolate some key ideas in these areas, and then we embedded them in problems. We found out that kids, in order to make sense of abstract rules and symbols, needed something to hang those ideas on. What gradually evolved was a problem-centered approach where the mathematics was embedded in contexts.

When we did workshops with teachers, they would say to us, "We can't isolate these ideas. We don't know how to string these activities together to build curriculum units like you're doing." Then, in the late '70s, we got a grant to develop some exemplary curriculum units, which evolved into the *Middle Grades Mathematics Project*. We then used those units in our workshops with teachers.

We were funded to do research to find out whether, if teachers were coached to use these units, they would transfer that whole spirit of problem-centered mathematics into the rest of their curriculum. One of the things we found out in that study—something that came through loud and clear—was that many teachers were not able to go back to their textbook and say, "All right, what's the important idea here in fractions? Instead, they kept saying to us, "We need more of these units. I can't write the curriculum like this. I've got all these things pasted into my curriculum, trying to emulate what you're doing." This was about the time that the National Science Foundation put forth the call to develop complete curricula, and we decided to apply for the grant.

When we were gearing up to develop the curriculum, Jim Fey had just finished a computer-intensive algebra project, where he wrote an Algebra I course using computers and software. We asked Jim to come on board and lend the high school per-

[1] See more information about the Show-Me Center on page ii.

spective. Susan Friel had done quite a bit of work in elementary curriculum development, and we asked her to come on board, bringing that perspective to the team.

One of the things that we always knew we wanted to do was use the CMP curriculum to help teachers. Our whole approach to teaching and learning was centered on two things: identifying and isolating important ideas, and then embedding them in interesting problem contexts. The curriculum provides help for the students, of course, but, primarily, it is a help for the teacher.

CMP is unique in that we don't do a spiral approach in the development sense. We take an idea, like equivalence of fractions, and we just stay with it. You need to stay with an idea so that students can build on it—and so that next time you come to that idea, you don't have to go all the way back to the beginning to relearn it. Once developed, ideas are used, not redeveloped. CMP isolates key ideas and goes in-depth. Rather than spiraling, we connect those ideas, and use them to build other ideas. The whole approach of isolating the idea, and going for that depth, is what makes our work different and powerful.

Rational numbers in CMP

In my opinion, rational number and proportional reasoning are the hardest concepts in the K–12 curriculum. It was a real struggle for us to come up with the right sequence of work in the rational number strand of the program; we spent a lot of time on it. In fact, the very first unit we designed was a unit on rational numbers, because we knew it was going to be hard. The result is that the rational number strand—particularly in proportional reasoning—is very strong in CMP.

Teachers, beginning in September, piloted the first rational number unit we wrote for 6th grade. In January, the teachers called us and said, "Look, we're still on this unit. We're only halfway through." We had written the mother of all units. We were really struggling with various models and representations, and the order in which we used them in the curriculum. What evolved as we rewrote that unit and began to write others was a theme that connected the whole development of numbers, tying rational numbers, fractions, integers, and even irrational numbers to the number line. That's one major model; we also branch out and look at other models, including the area model. We treat various forms of rational numbers—percents, decimals, and fractions—all at the same time, as just different names for the same number or quantity. The first unit on rational number, in 6th grade, focuses on equivalence and establishing benchmarks. We expect kids to be very fluent in some key fractions, key decimal representations, and percent expressions. We want them to be able, for any particular fraction, to say quickly what its decimal and percent representations are, to place it on a number line, and to use that fraction to make comparisons and estimations. The second unit of rational numbers, also in 6th grade, is where we develop the algorithms. There is also a rational number unit in the 7th grade, *Comparing and Scaling*, which focuses on proportional reasoning. Rational numbers and proportional reasoning continue to be used throughout grades 7 and 8.

Algebra

Algebra is also a very strong strand in CMP. When you have a problem-centered curriculum, very often the problems involve quantities, and those quantities relate in some way. It was very natural, then, for us to develop algebra using a function approach where we continually ask questions such as: What are the variables?

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How are they related? How can you capture that relationship? Can you use that relationship to make predictions?

After a general look at variables and patterns and ways to represent relationships between variables, we then look at a collection of problems that leads students to look at linear relationships. What's the pattern of change? Linear relationships, of course, are characterized by a constant rate of change. We depart from the traditional way of doing algebra, and move from linear to exponential relationships. We ask the same kinds of questions, but the pattern of change is different; it's a multiplicative structure, and gives a meaningful contrast to the linear. We then move to quadratic relationships, which are much harder because the pattern of change is more complicated. It's not as easy to find contextual problems that lead kids to come up with both the expanded and the factored form of a quadratic. We're reasonably happy with what we've done with that. Overall, the way we developed the algebra in CMP seemed to flow naturally from the problem-centered approach of the curriculum.

I do think you could do a problem-centered curriculum and go in a different direction than we did; you could start with structure. In CMP, structure comes more towards the end of the program. We have a culminating unit, *Say It With Symbols*, where—even though all along we've been capturing relationships with symbols, interpreting symbols, and using symbols to solve simple things—we come back and pull it altogether with more of a direct look at symbols and the syntax of symbols, like properties.

One big question for some middle schools, when they are about to implement CMP, is "What will happen to the course called Algebra I?" Several of our pilot schools initially decided to eliminate Algebra I in 8th grade, and to have all students in CMP. The real question is "What will students take when they go to high school? Have they already completed algebra?" That's a hard question to answer, because Algebra I varies widely across the country. Students in CMP have certainly had many elements of an Algebra I course. We've found that, in our pilot sites, when schools are using all three years of the CMP program, anywhere from one-third to one-half of the students, and perhaps more, are prepared to skip a more traditional Algebra I program.

Skill development

Early on in the development of CMP, our advisory board pushed us to assess students' skill development. They said, "Look, this curriculum is going to look very different—you don't see naked symbols streaking through it—and people are going to have a hard time accepting it." In order to convince people that the approach would work, they said we needed to provide some evidence that skills were not going to be diminished. They kept telling us, "We want you to test the basic skills." At first, we resisted, saying, "We're about more than that," since skill development wasn't our only focus.

Finally, they talked us into using a basic skills test to track students' development. It turned out, of course, to be essential. NSF gave a supplement to do a controlled experimental study in which evaluators pre- and post-tested in both CMP and control classes, using the Iowa Test of Basic Skills. The evaluation also included a test developed by the Balanced Assessment project that focused more on problem-solving. The evaluators gave the tests to students using CMP materials that were not quite the final draft but very close—one version away.

We were prepared to be very pleased if CMP students held their own in basic skills. Well, in 6th grade, even though the CMP students started out a little below the control groups, they increased at about the same rate. In 7th grade, again, it's a wash; they increased at about the same rate. In 8th grade, there was a statistically significant difference in favor of students in CMP. That was really surprising, even to us, since 8th grade focuses on algebra. At all three grade levels, on the problem-solving evaluation, CMP students did significantly better—and you would expect that.

In CMP, we probably spend more time on conceptual development than skill development. We believe that skill is very important, but we think the understanding has to come before students can become really proficient with the skill. We want the kids to be able to compute, but also to be able to describe their strategies and algorithms, and give examples of where they might use a particular skill to solve a problem. They need to practice that skill in many different contexts.

For example, in the development of addition of fractions, there is a problem that involves two land plots in the Midwest. Each plot is a standard section of land. Over the years, pieces of the plots have been sold off, so that different people now own parts of the plots. The question is, what fraction of each plot does each person own? At this point in CMP, the kids know about equivalent fractions, but have not dealt formally with addition of fractions. As they work through the problem, kids begin to talk about addition: "Mr. Jones bought this piece and this piece." Again, they don't know addition of fractions yet, but they begin to combine pieces using equivalent fractions. After that problem, the teacher helps students symbolize the addition of fractions. There are four problems in that investigation that focus on developing that algorithm. The concept and the skill will also appear on the homework. At the end of the addition investigations, kids are asked to describe how they would add two fractions—a culminating experience that really pulls out their algorithm and makes the mathematics explicit.

Another area in the curriculum that we struggled with, in terms of skill development, was division of fractions. We decided early on that we weren't going to develop it as formally as the other algorithms. We argued quite a bit about including it, and I myself argued on both sides. Division of fractions is there in the curriculum—kids can actually do problems involving division of fractions; they can figure it out. I think right now that it's just not prominent enough in the curriculum for teachers. Some people have latched onto that, particularly our critics. We will certainly add more on that topic the next time around, to make it more formal and add more work with symbolic statements. Right now teachers who feel their kids need more on division simply supplement it.

Implementation strategy

We recommend a three-year implementation plan for schools using CMP. We recommend that schools not start 6th, 7th, and 8th grade all at once, but rather implement gradually: 6th grade one year, 7th the next, 8th the year after. The 6th-grade units really provide a foundation for the rest of the curriculum. In the first year or two, the 6th grade probably won't finish all the units; teaching the program is slower the first time through. We recommend, in those first few years, using some of the key 6th-grade units in 7th grade and key 7th-grade units in 8th grade in order to accommodate that slower pace.

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Professional development

We also recommend a three-year plan for professional development. It takes time for teachers to become comfortable with CMP. In the first stages of professional development, teachers need to focus on the mathematics. If you don't give teachers help with the mathematics, then the inquiry and all the questioning techniques are for naught. While you are addressing the mathematics, you also model the teaching, teaching the teachers as you would want them to teach.

One real challenge is helping teachers stay focused on the mathematics. Teachers tend to want to focus on good ways to organize materials. Management is important—without some good management techniques it's very difficult—but that has always been part of teaching. I think we're not accustomed, as teachers of mathematics, to looking for more and more mathematics in a situation. In particular, if it's a problem in a contextual setting, there can be a lot of associated mathematics. We also focus on helping teachers become better at listening to kids' mathematical thinking, listening to what kids are saying and taking advantage of it.

In the second stage, we stand back and talk about the teaching. The inquiry-based teaching approach in CMP is something that is new for teachers. It's very different than standing at the front of the room and saying, "2 + 2 is 4. Now memorize that." The whole idea of learning mathematics through problem-solving is new. Some people call it "guided discovery." I don't think it's discovery, because I think that means kids are going to say whatever they want, and you as the teacher wait until they discover it. That's not what this approach is about at all. It is very guided—as the teacher, you know where you want to go. You want to help the kids get there, and to develop their understanding.

We use a structure for the pedagogical approach called "Launch–Explore–Summarize." For example, in the teacher's book, we talk with teachers about how you could launch a problem. It's a very subtle thing. Some teachers launch a problem, and in doing so, give away so much that there's nothing left to explore. What is the role of the teacher while kids are exploring a problem? How do you push kids? How do you redirect? The summary can also be difficult. How do you pull it all together? What do you do with the various conjectures and strategies that students suggest? What do you have on the table, mathematically, at this point? What do you want to pull out of the discussion?

The third stage for teachers is when they're beginning to look at assessment: "What do the students really know? How can I use the assessments effectively? How does this information affect my teaching?" In the third stage, teachers are focusing on understanding what students know and using various techniques to help them understand that better.

The three-year plan for professional development usually involves summer workshops, and then as much follow-up as possible during the school year. The follow-up is important because it gives teachers time to plan together—it never lets them go into their classroom and just close the door. It helps keep them accountable for teaching the program, and for sharing their experiences.

In some CMP schools, classroom coaches support teachers in using the curriculum. Coaching is a powerful tool for supporting teachers—it is very effective, but also labor-intensive. A coach comes into your classroom and observes, and has conversations with you about what is happening. It's not something we've done a lot of in this country. Usually the only person that comes into your classroom to

observe is the principal, who probably comes in once a year to evaluate you. Teachers hardly ever talk together about teaching techniques or student learning; that's not a common theme in our culture.

Technology

Given where schools were in 1991, we felt we had to be conservative on the use of technology. CMP assumes that students have a calculator—any calculator—in 6th grade, and graphing calculators in 7th and 8th grade. We recommend that you have a statistical package, but it's not required. We also have some geometry investigations that rely on LOGO[1], but again, they're optional.

The quandary for us when we were developing the curriculum was, if we made CMP technology-intensive, what would happen to the schools that didn't have access to the technology? For example, geometry is a natural to make computer-intensive because there's such wonderful software out there for geometry. You can argue that if you include work on computers for geometry, it will push schools to begin using them; but on the other hand, if they don't have the money for the technology, teachers won't use these units. When we revise the materials, or start again from the beginning, we will be much more aggressive on technology; I don't think technology is as much of a hardship now as it was.

The graphing calculator is an essential tool to promote the function approach in looking at rate of change. The kids love to use the table. The table is often their first representation in solving something. Of course, the use of calculators is a political issue out there. Many people still think of calculators as the devil.

Impact data

Because 7th grade had a heavy focus on proportional reasoning, Jim Fey, Bill Fitzgerald, and David Ben-Chaim did a study of students' proportional reasoning. CMP students significantly outperformed the non-CMP control group in proportional reasoning in all contexts studied. The proportional reasoning test, interestingly enough, also indicated that the 8th grade CMP students did better than the 7th grade CMP students. In CMP, 7th grade is our proportional reasoning year. This meant that there was some indication that CMP kids are not only carrying knowledge from one grade to the next, but also deepening that knowledge. That trend is something that we've seen suggested now in two or three different kinds of studies, and we would like to continue to look at that more formally.

In addition to the studies I described earlier, we have data from a number of sites across the country that have been using CMP. All of these reports, to date, show substantial increases in student performance with a rare class showing more flat performance. There have also been several dissertations and other studies done on CMP. We post these kinds of reports on our website in a section called "Studies and Reports."

Looking back over the development of the CMP materials and the emerging data, we are quite pleased with the outcomes. They confirm our belief that a good curriculum in the hands of good teachers with the support of the administration and long-term professional development provides the kinds of mathematical experiences that empower all students. ■

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[1] LOGO is a programming language that was developed specifically to be used by children.

MARY SHAPIRO ▸ MATHEMATICS TEACHER, GRADES 6–7

Mary Shapiro teaches 6th- and 7th-grade mathematics at Sterrett Classical Academy, a public middle school in Pittsburgh, Pennsylvania. *Connected Mathematics* is being used in all the middle schools in the Pittsburgh Public Schools, a mid-sized urban district. Mary has taught for 31 years, 17 of which have been in middle-school mathematics. In addition to her experience using *Connected Mathematics* with her own students, Mary spent two years out of her classroom as a demonstration teacher, supporting other teachers who were beginning to use *Connected Mathematics*. As a demonstration teacher, she planned and delivered in-service events and provided hands-on assistance in colleagues' classrooms, demonstrating lessons and assisting in their teaching. Mary is now back in her own classroom full-time.

Goals for students

What I want most is for my students to understand concepts rather than to just memorize skills. I want them to understand why everything is the way it is. For example, we're working on fractions, decimals, and percents. So when they're adding 3/4 and 1/2, I don't want them to concentrate on finding the least common denominators. I want them to think in their minds about what 3/4 means, and then if they add 1/2 to that, how would that work? I'm trying to give them concepts. That's my biggest goal.

I also want my students to learn how to think and reason through mathematics, to depend on themselves—to try to become more independent and be more confident that there is a solution and that they can reach it. I think urban kids are not confident, and they don't stick to solving a problem because they really don't think they can do it. I would like to instill in them a confidence and a love of math, encouraging them to discover that they *can* find the answer.

Instructional approach

Connected Math uses a very inductive approach. It takes kids step-by-step and gives them all of these little problems. Then, all of a sudden, they can see the whole concept. When it's time for the rule, they already know it because they've done so many examples. Kids have had experiences with all of these problems so the rules make sense. It's wonderful the way the questions lead them into the rules.

The traditional basal text we used before was very skill-oriented. As long as students knew how to perform the algorithm, they were fine. With *Connected Mathematics*, they have to understand what they're talking about. It's very geared to teaching the concepts. I can tell you, I will never go back again.

Students are developing concepts they never had before. When they came into 6th grade this year, some of my students didn't even know that 1/4 and 1/4 meant 2/4 together, or 1/2. They would say that 1/4 and 1/4 was 2/8, adding the denominators. Now, they're able to take 1/3 of 300, 2/3 of 300 very easily, and they're really developing their concepts of fractions. They're in the middle of a unit now that shows them how a fraction, a decimal, and a percent are related, and they're getting it.

Assessment

With *Connected Math*, we have different types of assessments that we never had before. Students have different ways of showing what they know—it's not just limited to a timed test. Kids have projects that they work on that aren't limited to the 40-minute class period. They can go home; they can use some supplementary material; they can talk with another person about it; they can work at their own leisure. Sometimes we'll have partner quizzes during which students will work with a partner and discuss the problems together. We have reflections where students write about mathematical ideas. At the end of each chapter they're asked summarizing questions and are encouraged to express their thinking verbally. So there are just all types of assessments that kids enjoy.

Connected Mathematics gives students different ways to express their knowledge. Some kids can't perform under a time limit. Some kids learn better working with

a peer, or being able to talk a little bit. In the materials, there are also adaptations that can be made for learning-disabled kids. I remember going to one teacher's room last year to demonstrate and she had a lot of inclusion kids. She was just so pleased with how the program worked out. Kids worked with partners and there were so many different projects that all kids were able to participate and perform well, so it was very powerful for those children with special needs. With CMP, everyone has an opportunity to participate and to show what he or she knows.

Implementation challenges

You have to be so well organized to teach like this. You have to be a highly motivated teacher, because it is so much work, especially the first time through. I am constantly trying to be organized, because if I miss a beat, I lose the kids. So I have everything prepared and ready to go, and then there are interruptions, or I get panicky and I can't find my overhead. If you want them all in groups, working together, passing out materials, all in a 40-minute block, then by the time you get past all that set-up, there's little instructional time before the bell rings. Sometimes it feels like by the time I pass out all the calculators, it's time to collect them again!

I also think we need smaller class sizes. I have 35 kids in one room. I'm teaching three different CMP units, and I don't have my own room, so I have less-than-ideal conditions, and it is very difficult. It would be so wonderful to have the right conditions, like a small class size and my own room, and maybe some carpeting for the acoustics. It is frustrating to know what should be done and not have the proper conditions to make it happen.

This is my first year at the school that I'm in right now, and it's a very traditional school. The 6th-grade students are quite a mixed group. We have some very independent learners and some who really don't know how to learn on their own at all. It's been a real challenge, and I've found that, more than I would like to, I'm in front of the classroom with the overhead projector and we do things together. I want my students to become more independent, and I'm having a very hard time with that. They seem to need me to start them out, to lead them. They can't do a lot on their own. They don't just jump into a concept—"Oh, this is good, let's start doing this..." If I don't introduce it, if I don't lead them, then it's too distant from them and they would rather sit back and talk about something else unrelated to math. But if I give too much direction, then they lose interest. I'm trying to get kids to work with each other, to work cooperatively without giving them too much of a lead in, without my being on stage all the time. I struggle with that all the time, and I'm hoping as the year goes by, and maybe next year when they're used to the curriculum, we'll see a change. But right now, I feel like I'm doing too much of the teaching.

The reading level of CMP is very difficult for my 6th graders. Some of the questions in the books could have been simplified somewhat. I have to go over everything I do with kids, even their homework questions. We read them before they go home so that they know what's being asked. For my 7th graders, the reading level is fine because the group is quite capable, but for your typical urban kid, I think the reading level is very difficult.

Preparing for high school

In my 6th-grade classes, I'm totally using *Connected Mathematics*. In 7th grade, with the prealgebra group, I use *Connected Mathematics* also, but toward the end of the year, I have to switch into more traditional preparation for algebra. The

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school mandates this change. Algebra in the 8th grade is taught traditionally because that's the way the high school does it.

For my 7th graders, what I tried to do the first semester was use the *Connected Mathematics* units, including *Variables and Patterns, Stretching and Shrinking*, *Comparing and Scaling*, and *Accentuate the Negative*. I've used these four books as a basis, to give them a little bit of readiness, so they understand the concepts when they go into the algebra book—because we do have to take them into the traditional algebra book.

At the middle school we're teaching all these concepts, and I'm afraid when kids get into high school, teachers are going to want them to know how to manipulate equations. I'm afraid that if they haven't been taught that way, they may be penalized for not knowing how. We've worked more on figuring out the problems, understanding what they mean, and reading a story and developing it into an equation. That approach doesn't fit as well at the high school level.

Selecting *Connected Mathematics*

We have a very strong mathematics leader in Pittsburgh. She's very active in mathematics reform, and she was the main force for changing the curriculum. She invited all middle-school teachers to come on Saturdays and view different types of new curricula. She used the library at one of the administration buildings, and she had all the different curricula in the room for about three weeks. At various times, publishers would come and explain what their curriculum was about. It was open to any teacher who wanted to come and view it. Then the teachers voted on two programs that they liked, and those were *Connected Mathematics* and Glencoe's *Interactive Mathematics*. Those were the two that were then piloted in our district, and at the end of the piloting, all the teachers got together and we listed all the strengths and the weaknesses of each curriculum. It took us hours of discussion and debate, and we finally voted on *Connected Mathematics*. CMP provides more structure for students and it's very strong with the rational numbers, which is a big part of what middle-school mathematics is about. That's why we finally selected it.

Pittsburgh teachers have been connected with people at Michigan State University (where *Connected Mathematics* was developed) for many, many years. I got started probably 10 years ago, using certain units at the 6th-grade level that they had developed as part of the *Middle Grades Math Project*, a precursor to *Connected Mathematics*. There were two units, called *Mouse and Elephant*, and *Factors and Multiples*, that we were expected to introduce into our curriculum as replacement units for chapters in our traditional books. I had a demonstration teacher come into my room and work with the kids, since it was so very different, and show me how this was to be done. The kids were so excited and so tuned in to it, and they really enjoyed what the demonstration teacher was doing with them. They were out of their seats, they were involved, and they were enjoying it. And they understood some things that I thought they would never be able to do. It was the student reaction that was so wonderful. I would watch what the demonstration teacher did and then I would do that with the rest of my classes. And that was my introduction to teaching this way, and to this kind of curriculum.

Supporting other teachers

When I became a demonstration teacher, we were piloting *Connected Mathematics*, and I taught some demonstration lessons from the program. In my second year as a demonstration teacher, we were fully implementing *Connected Mathematics* at the 6th grade, so I and the other demonstration teacher went to the 13 different middle schools in the city to support people who were teaching 6th grade.

Of course you have some people who are really excited and enthusiastic about teaching the new program, but then you have a lot of very traditional people. Last year, at the 6th-grade level, we had several teachers whom we thought we would never be able to get through to, who would really be tough. We just went in with the attitude that, "We know this is tough, and we'll do anything we can do to help you." We went to their rooms first—the very traditional people—to get them started. We just told them, "This is the curriculum that we have this year. It was adopted by the school board. It's not easy, and we're here to help." I would run off everything they would need for the whole day for their classes, and then I would go in and demonstrate one class and show that it could be done.

For example, we heard about a teacher who had just one 6th-grade math class and he didn't think it was worth bothering with it, so I went out to help him get started. He said, "You found me." He felt really guilty, because everyone else in his school teaching 6th grade was on board, and he knew he was supposed to be teaching *Connected Mathematics*, too. I taught his one class for about three weeks. At the end he laughed and said, "I guess I'm just a '50s man in a '90s world." He was very amicable. I think it made a difference that he saw how his kids responded to it. By the end of the year, we had every 6th-grade teacher at our 13 middle schools teaching out of *Connected Mathematics*, and we were really pleased.

We've had summer workshops for the teachers, and there's also support for anyone who's new. Sometimes at the last minute before school starts, things get switched around and there's a new math teacher who was originally supposed to be teaching reading—even those people are scheduled to come in for two days every two months. Every time teachers are ready to start a new unit, they come in first for in-service. Everybody's been in-serviced. Everybody's been given help with a demonstration teacher if they ask. Now, everybody's going to have to get used to teaching CMP in his or her classroom. It's almost like starting teaching all over again. It took all of us years to perfect our technique, so it's just going to take us years to get this new approach down pat. It's not easy.

I think giving teachers a chance to vent is vital. Some of them are angry at first, asking, "Why do we have to do this?" At our in-services, we gave people an opportunity to vent and also told them, "You're right. It's not going to be easy." We also had an opportunity for everybody to share, and that sometimes turned into a chance to vent, too. And then we would laugh about it together. We said, "Yes, we know what you mean." We would ask teachers to bring in "triumphs" and "challenges." We would ask for student work—some of it was really good and people would be enthusiastic about it. When teachers saw an excited colleague bringing in work to share, that helped the cause.

You need to be able to say to teachers, "I know, this is tough. What can we do to get it across?" You have to give teachers a chance to complain and gripe and let them know that you really do understand. It really is hard to do—and sometimes the copy machine's down or you don't have a room. There are so many things that happen that can get in the way of doing the job the right way. ■

HEATHER CALDER ▸ MATHEMATICS TEACHER, GRADE 8

Heather Calder is a teacher at Jordan Middle School in Palo Alto, California. Prior to teaching in Palo Alto, she taught in a rural area in central California. Heather has always taught math at grades 6, 7 and 8 for both honors and regular tracks. She is currently teaching *Connected Mathematics* in her three sections of regular 8th-grade math, and also teaches two sections of algebra for accelerated 8th graders, which is equivalent to a freshman algebra course.

Math has been an issue of controversy in Palo Alto for many years. While Heather fully supports problem-based learning, she and her colleagues also recognize the need to strike a balance and develop both computational skills and problem-solving aptitude in her students.

Why *Connected Mathematics*?

In the three or four years prior to starting our adoption, teachers in our school were making up their own units for mathematics. We were teaching from binders that we had put together—much of the content was problem-based—and then we'd share what we had with each other. When our adoption committee looked at the new programs, we saw a lot of the same problems that we had been doing. We looked at about 12 different math programs, including the Addison-Wesley and Prentice Hall texts. We chose to pilot two programs, *Connected Mathematics* (CMP) and *Mathematics in Context*, which seemed to be best suited for what we were doing. We ended up deciding to go with *Connected Mathematics*, and we are now in our second year of implementation.

When we were piloting *Connected Math* and *Math in Context*, teachers liked both programs. But teacher-friendliness in the curriculum is a huge issue. At the 6th-grade level, some teachers are generalists rather than specialists. Some are strong in math and science and that's what they teach, but some are not. *Connected Math* went over better, especially with 6th-grade teachers, because there's more guidance and a little bit more structure in it. The teacher materials are a lot easier to follow. *Connected Math* was much more teacher-friendly, in our opinion.

Connected Math is made up of units, which makes it easy for someone to pick it up and go to a certain section. A teacher could leave it for a substitute and say, "This is what we need to do today." It tells you how to launch the exploration and how to guide the students through the exploration and then how to provide some closure. There are also homework problems in the book. *Connected Math* is laid out for you; I don't know that all teachers strictly follow it, but at least the outline is there for teachers who need that.

I like CMP a lot. The content is extremely rigorous, in my opinion. There is a tremendous amount of algebra in the 8th-grade year. And I'm impressed by what the students learn over the span of a year. It's also been nice to be able to give students a book in which they can follow through at home with the activities that we're doing in class. That's been extremely helpful.

Development of the mathematics

CMP seems to be working with our students. They are learning and seem to be enjoying it and really understanding the content of the math instead of just doing it mechanically. They understand where the numbers come from, and how and why they work. They understand the math and the concepts rather than just memorizing formulas.

Last year I taught *Filling and Wrapping*, a 7th-grade unit that covered three-dimensional geometry. Students would come up with all the formulas for areas of different shapes, like a trapezoid. I didn't instruct them on the formula. Instead, I said, "I couldn't tell you what the formula is for a trapezoid. I don't remember formulas like that." So we derived it and learned where the formula came from. If students couldn't remember it, they could draw the pictures to build it and come up with the formula on their own. It was a great example of them understanding what's going on with area instead of just plugging numbers into a formula. I see students thinking through things and becoming better problem-solvers, rather than just memorizing and then not remembering the formula next year.

Many of my students also understand the concepts better. This year, when we did the 7th-grade unit *Moving Straight Ahead*, students were trying to understand the concept of the y-intercept and slope. The unit talks about what slope is—not how to find it, but what is it? When we went into the next unit, they said, "Oh, I get it now." It doesn't always happen right away. Sometimes a concept builds and then, all of a sudden, students get it because they've got this great background of the various parts and they are able to put it all together and really use their understanding to solve problems.

The CMP curriculum really builds on each unit. We did the *Moving Straight Ahead* unit, working with writing equations of lines in slope-intercept form. And then we just did another one, *Thinking with Mathematical Models*, which built upon it. If a student didn't have the unit before, the next one would be extremely difficult. That's been a concern that's been expressed by teachers: what if the student hasn't had the appropriate experience or what if they're new to the district? I suppose that's always been a problem, but now there's more being taught in the middle school. For example, we didn't teach slope-intercept form and the Pythagorean theorem in 8th grade before.

CMP units

In our first year of implementation, we used a 6th-grade unit in the 7th grade that deals with fractions; it's called *Bits and Pieces II*. It covers decimals, percents, and fractions really well. It has stuff that students can relate to, like calculating tips and tax. Students brought menus from local restaurants to class. We looked at the menus, ordered food from them, and then calculated all the costs. They could easily talk about CDs at Tower Records and about clothes at Macy's. We looked at ads in the newspaper and saw how much K-Mart marked down their prices, and asked, "How much are you really saving?" We talked about how advertising works and how advertisers will make something sound appealing but mathematically you may not be saving money. It is an interesting unit for the students because it brings in a lot of stuff that they are interested in, but important mathematical concepts are there, too. There are some really good problems in there and it is easy to build on that and develop those skills. They understand a lot after that unit about when to multiply fractions or when to divide. That's a huge thing—the "When do you do this?" question.

I also really like the 7th-grade unit on probability, called *What Do You Expect?* It's not just about what's equally likely or whether something is fair or not, but it also actually gets into expected value. We shoot baskets in the classroom and then, based on that experiment, come up with the expected value. We ask, "If a student were to go shoot one-and-one or two-shot free throws, how many could we expect them to make?" When we play this game, I want to teach something from it, to take advantage of the teachable moment. Activities like this are really good as far as raising some good follow-up questions, like: "What was the theoretical probability? What was the experimental probability? Compare them. Why might they be different?" The students get very involved and have fun.

Skills development

CMP is very rich, so students have to have the appropriate skills to do the problems that come up. So, for example, in 8th grade, we're working with the Pythagorean theorem. We just finished working with slope-intercept form and writing equations of lines. It's a perfect time for me to review fractions. So I'll use frac-

I see students thinking through things and becoming better problem-solvers, rather than just memorizing and then not remembering the formula next year.

tions for the slope and the students will get practice with their skills as well as learn about the slope-intercept. It's real easy to do. We'll review fractions in here and easily integrate skills practice into the lesson without spending an entire day reviewing.

There are ACE (Applications–Connections–Extensions) problems after each investigation and some of the problems in there are pretty much skills review. But I don't think it's enough. If it is a skill that you want to reinforce with your class, you definitely have to add more to it. A lot of times we add by building some questions to make an activity a little bit richer. I don't feel the program is deficient, but still I add skill practice where I feel students need it. There has been a complaint from some teachers that there is not a whole lot of skill practice in CMP, so we've also adopted a hardbound book, *Achieving Proficiency in Mathematics* (APM). That book is primarily skill-based, and it stays home all year.

Assessment

There are different ways of assessing students with this program. Testing is not the only way. Students do group assignments and homework that we go over in class. We do activities in class almost daily and have a lot of discussions about the results. There is a lot I can observe during activities, when students are experimenting with things and using manipulatives. It is pretty easy to walk around and see how much they understand by watching them as they work on a problem.

The assessment in the curriculum is okay, but I don't know any teachers who use the tests right out of the program. There are Unit Tests, which are individual assessments. There are also Check Ups that are meant to be partner or group tests, but the issue of grading students as a group on a test is not something that goes over well with a lot of parents and students, so I don't use them as tests. We also do group activities and an occasional group project, and I pull some of the questions for those off of the assessments. A lot of the assessment questions are good, but some don't seem challenging enough to assess what students have learned or they don't cover the whole spectrum of the unit. Many times we write more challenging problems and add them. There are question banks in the back of the Teacher's Guide that I can use for test questions. I might pull from those and modify the questions a little bit.

Implementation

Implementing the curriculum is an issue in itself because there are a lot of units at each grade level that teachers need to go through. This year at 6th grade, they're implementing what they need to implement so that they'll be teaching all the 6th-grade units. At the 7th grade, we aren't teaching all the 7th-grade units. There are still one or two of them that are being taught at the 8th grade, and there are a couple of 8th-grade units that aren't being taught in 8th grade. We've put them aside at this point.

There are also some pacing issues we faced during the first year. Sometimes the time frame for the activities is a little bit off. There are times when an activity takes 20 minutes but a whole period is reserved for it, and other times, you're told an activity can be done in a period but it ends up taking you three days. You have to introduce it, explain the activity, go through it, and then follow up on what you've done. Following up usually takes a good amount of time, making sure that the students understand what they did. Some of those ACE problems at the end of

the investigations are very difficult. They are good problems and you want to spend time on them in class; you don't want the kids to just turn them in and not discuss them. But sometimes it can take 20–30 minutes to go over some of those problems, and then you've only got 25 minutes left to start an activity.

The problems are engaging and the teachers enjoy that part of it. But the time that it takes for teachers to prep with the program is a lot. It feels like many teachers are still making things to supplement it. Maybe that will change after it's been in place longer, or maybe that is true of any program and there's no perfect program out there. The 6th-grade teachers at Jordan spent time over the summer and they developed supplementary units for every single 6th-grade unit. I can spend one to two hours prepping for the next day myself. That's not different from before, but I was hoping it would be now that we have this curriculum.

Support for teachers

Teachers who are working together at a certain grade level will often plan together. Sometimes the investigations in CMP are very similar, so we'll decide to do one and skip another one for right now. Last year when we were going through some of these units, we didn't feel comfortable doing that. We didn't want to miss out on something important. But the reality is, since we have a limited amount of time to get through a lot of material, we have to pick and choose. This isn't a judgment that a teacher wants to make alone, so we work as a group.

When I taught at the other middle school, we were given release days for planning. The two of us who taught 7th grade would take a day to go through a unit and really plan the entire thing together. That was extremely helpful. At Jordan, planning is done on our own time. I work closely with the teacher who teaches the other half of the 8th grade, but we have to meet after school and on our own time. Since the teachers at the other school have taught some of the CMP units before, we'll go over there sometimes and work with them on a unit. That collaboration between the two middle schools has been really helpful. But again, that's totally on our time, after school. The money's just not there for release time.

The two of us who taught 7th grade would take a day to go through a unit and really plan the entire thing together. That was extremely helpful.

Meeting a range of learning needs

Our accelerated students are not solely in *Connected Math*. They're pulled out in 7th grade for prealgebra, which uses a combination of 7th-and 8th-grade *Connected Math* units, and then they're in an algebra program in 8th grade. As far as meeting the needs of the high-performing students in our regular classes, there is no issue—there are a lot of opportunities for extending the math. The ACE problems and the extensions are really good for those students. I can offer those as extensions or extra credit for students who might want to build on what we've done. The program also does a good job for students in the middle range. It really pushes them. I like the high expectations of the curriculum because the students will meet those expectations.

My concern is for the lower-end kids. I have resource students who are doing okay in CMP, and they have outside support where another teacher can explain the concepts to them. But these are hard concepts. They're not that easy to understand. I don't know whether it's just this curriculum, but I just don't see a lot of support in there for these students. There's not a lot of explanation in the books, so it depends on the teacher to give students notes on an activity. If students don't write notes down, then they go home and are left with a book that doesn't fully explain the

concept. There's nothing that students can look back to in the book and say, "Oh yeah, this is what we did and this is why we did it." If a student isn't comfortable approaching the teacher for help, and the parent doesn't see anything in the book to help them, that student could get totally lost. Some more text about the ideas in the curriculum would help support those kids better.

Parents

This year, I haven't heard any negative feedback from parents about the program. What has helped is the direct instruction program we have at Jordan. It's a more traditional approach to teaching, and parents can enroll their students in that program if they choose. People who were upset with our curriculum and our way of teaching have put their students in the more traditional program, and that has reduced the complaints. We have one traditional section in 6th grade and two in 7th grade—a regular 7th and an honors prealgebra. Next year, there's going to be a regular 8th-grade section and an algebra section specifically called "direct instruction," as well. But there's really only one class of each of those, so it's not a huge fraction of the community.

Last year wasn't bad, either. We heard a little bit from parents who were not happy with the curriculum, but nothing like three years ago, when they demanded to know "Where are the skills?" Parents are happy when they have a resource book—*Achieving Proficiency in Mathematics*—at home that they can use to do problems with their kids. There was a group of people who spent a tremendous amount of time correlating all of the CMP units with the problems in the resource book. We can send home notes to parents that say, "For this particular unit, these are the pages in the APM book that correlate with the areas that we're studying."

Overall, I'm really happy with the CMP curriculum. I enjoy teaching it. The students enjoy learning it. It's a very strong curriculum and I'm really looking forward to having it fully implemented. Next year will be the first year that students will have gone all the way through the program. I'm excited to see what students will have learned by the end of 8th grade. ■

JANEANE GOLLIHER ▸ K–12 MATHEMATICS COORDINATOR

Selecting *Connected Mathematics*

As we reviewed materials for our curriculum selection, we organized a professional study group called the Middle School Math Project. Principals and key teachers from every building participated. We did some in-services—invited guest speakers to talk about tracking, about the differences between conceptual development and skills development, and about the difference in the philosophies of various programs. During the same time period, we provided the middle-school teachers with opportunities to learn about and use standards-based materials. We offered a class, "Math for Middle School Kids" which involved participants using a variety of investigations to build conceptual understanding. As we were reviewing the publishers' materials, the project and the class helped teachers and administrators understand how math could be different. At the end of the year, we decided to pilot *Mathematics in Context* (MiC) and CMP.

We set up the pilot around the number strand. To begin the year, half of the teachers used MiC and the other half used CMP. About every six weeks, teachers got together to talk about the different approaches and compare the programs. Halfway through the pilot, teachers switched materials, so everyone tried some of each program. We adopted CMP for middle school two years ago, and now everyone uses it. We could have worked with *Math in Context*, but CMP seemed better matched with our proficiencies—we have district proficiencies that are aligned with the national standards. In terms of philosophy and pedagogical approach, the two programs felt pretty similar and quite compatible. However, teachers felt that CMP better met the needs of all of their students. They said they could meet the needs of the lower-end kids, as well as take the higher-end kids higher.

We also liked the flexibility of both programs. In CMP, there isn't just one textbook for each grade—so you don't have a 6th-, 7th-, or 8th-grade text—but instead you have separate units that you can use with students at appropriate times. When we designed the pilot, 6th grade teachers were able to use 6th-grade units. Because the new curricula were much more advanced than our previous program, we had to pick and choose units that were appropriate for our 7th- and 8th-grade students. For instance, our 8th grade started with some of the 7th-grade units, and the 5th grade piloted some of the 6th-grade units. We liked the flexibility that the individual units gave us, especially during the first year of implementation when the program was new for everyone. We wanted to grow into the program in a way that was appropriate for our students and staff.

Teacher training and support

About 60% of our teachers piloted CMP. Before they began piloting, they came for two days in the summer to learn about the program and its philosophy and to review the first unit in depth. Six weeks after school started, they returned to debrief the first unit, troubleshoot management issues, and study the next unit. This happened again six weeks later. Our teachers had a lot of staff development during the pilot. When we began to implement, they became our teacher leaders. We had built a corps, because 60% of the teachers had at least some experience with CMP.

Janeane Golliher is in her fifth year as the K–12 Mathematics Coordinator in the St. Vrain Valley School District in Longmont, Colorado. Before that, she taught elementary school for 19 years. The St. Vrain District is located in the foothills of the Rocky Mountains and serves about 18,000 students from 13 communities. Just over 20% of the students are minorities.

The district has three large high schools, three middle/senior high schools (combined middle and high schools), five middle schools, and 18 elementary schools, five of which are bilingual center schools. At grades K–5, *Investigations* was recently selected, and *Connected Mathematics* (CMP) is being used for the middle grades. At the high school, there are two programs—the *Interactive Mathematics Program* (IMP) and a more "traditional" program that uses problem-based texts such as *Concepts in Algebra*.

I would advise a district just starting CMP to think about providing teachers with a lot of training opportunities and a common planning time so that they can talk to each other about their successes and concerns.

It's important to make sure that you're doing a lot of very careful professional development. You have to have sustained, high-quality training. I think that's key. You can't just give teachers the units at the beginning of the year. Even if you spent two weeks in the summer training everybody on every unit and then sent them out, I don't think it would be as effective. Teachers really need to come back periodically and hear what's working, what's not working, and share ideas. You also need to have good facilitators who have used the materials and are comfortable talking about the program and supporting their colleagues. I would advise a district just starting CMP to think about providing teachers with a lot of training opportunities and a common planning time so that they can talk to each other about their successes and concerns.

Around the time of our implementation, a district near ours decided to opt out of the state systemic initiative (SSI), and we had the opportunity to take its place. All of a sudden, we were given $80,000 for math and science and we were able to offer the kind of professional development we would not have been able to offer before. We also used Eisenhower funds to invest in teacher education.

The year before we implemented CMP, we were able to send 17 of our 50 middle-school math teachers to Michigan State University (MSU) to learn about the program. Last year we took 15 more teachers. This opportunity was also open to resource teachers or bilingual teachers who spent at least 50% of their time teaching math. In addition, we took advantage of a grant that offered training in CMP for a state team, and two of our teachers were sponsored to go. These two teachers attended leadership training at MSU for three consecutive years and have been an invaluable resource to the district.

Changes for teachers

It's hard as a teacher, especially when you think you've been successful for 20 years, to say, "Now I'm going to do something different." It is important that experienced teachers begin to understand that there may be different ways of looking at a problem and that techniques exist that involve group work and group presentations. It's also important for them to understand why the change is necessary.

Many of our middle-school teachers do not have math certification, but there's a tremendous amount of information in CMP that helps teachers understand the mathematics behind each lesson. The mathematics at the 8th grade is at a significantly higher level than our previous program so the teachers who don't have a math background are struggling a little bit. Teachers are eager for training in math content. They demand it. If you have a program that teaches procedures, you can memorize the algorithms—you may not feel totally comfortable with them, but you can at least memorize them. You can't memorize conceptual understanding. You can't anticipate all of the questions that students might ask or know the right responses to probe for understanding. Teachers need help in learning how to be more sophisticated when questioning students. If they don't understand what the kids are discovering, they won't know the questions to ask to help students move forward with their thinking.

We are offering an algebra class this summer for teachers to advance their level of mathematical knowledge. The fact that we have 80 out of 350 elementary teachers registered for this class shows that, district-wide, our staff is beginning to recognize that we all need to increase our understanding of mathematics.

Assessment

One of the biggest changes for us has been assessment. The purpose of assessment has changed. Teachers can no longer average scores on homework and tests to come up with a student's grade.

CMP contains various kinds of assessments. You can use the mathematical reflections, you can use the investigations, or you can do a portfolio. In addition, the program provides a Unit Test and a Unit Project, which look a little more like the traditional assessments with which teachers are familiar. This helps new users make the transition and become more comfortable using the new forms of assessment. The adjustment takes time. Teachers' concerns move from issues such as the amount of time it takes to grade a journal to "How do I really assess the students' work?" I've seen a gradual change as teachers become more comfortable using the program. A question that is still a struggle for us is how to reconcile these various assessments with a report card grade that is still comprised of As, Bs, Cs, and Ds. We're working on that.

Graphing calculators

Another challenge for the teachers was learning how to use graphing calculators. Before we adopted CMP, we didn't have access to graphing calculators at the middle-school level. We scrounged for funds and were fortunate to find district support to purchase calculators. Then we had to learn how to use them. A couple of the high school teachers stepped up to the plate and volunteered to help us with in-services. As a result, the high school teachers are pleased that our 8th graders are learning to use graphing calculators and coming to them with a basic understanding of the calculator.

Building support with administrators

A key piece of support is getting administrators to understand what you are doing and why you are doing it. An administrator needs to know how to evaluate a teacher based on the kinds of things that he sees in the classroom rather than on whether kids are sitting quietly in rows working on skill sheets. I don't know of anyone at the middle-school level who does not support the program now, but it didn't start that way. Teachers have done a wonderful job of educating principals. In addition, we have a strong director of secondary education, one of the best in the world, and she has done a lot of professional development with the principals.

Working with parents

Initially the most challenging part of implementation was the parents. We didn't provide parent education. We pretended that parents didn't exist. This created some problems during the piloting stage. We couldn't afford to buy a book for every student, so only copies of homework pages went home. Parents became suspicious because they couldn't see the book. If a parent had questions, many pilot teachers were uncomfortable trying to explain the program. We learned that we really needed teachers to feel secure enough to be able to talk to parents about what their students were doing. They needed a basic understanding of the difference between conceptual teaching and skill teaching. By the time implementation began, a key part of the training for teachers addressed how to talk to parents and what to do on parent night. We discussed the philosophy of the program and pre-

Teachers' concerns move from issues such as the amount of time it takes to grade a journal to "How do I really assess the students' work?"

Most of our parents are also pleased with it. They see their kids understanding things that they never understood in math, and they see their kids enjoying math.

pared activities that would help parents become familiar with the new math program. Had I known at the beginning what I know now, we would have been more proactive in working with parents.

Articulation

If I were giving advice to a district just starting out with CMP, one tip I would give is to think about articulation across the different grade levels. We really made a mistake on the issue of articulation. We should have been thinking more about articulation between the middle schools and high schools. Now that the 8th-grade program is fully in place, some kids don't need to take algebra in high school because there is so much overlap between the CMP algebra strand and our high school algebra course. We knew what would happen with the traditional program, but we didn't build the bridge that we should have with the IMP (*Interactive Mathematics Program*) teachers. Now, as we implement the new elementary program, we have made it a priority to talk to the middle-school teachers and make adjustments in our curriculum to capitalize on our students' strengths.

Impact on students

With regard to the mathematical concepts in CMP, I think it's the best program in the world. I'm not in the classroom, but I have gone to the training in Michigan for three years and I observe classes in our district. Certainly the conceptual understanding and the strands—algebra, geometry, number, and data—go far beyond what we have ever done before. I'm really pleased with it. Most of our parents are also pleased with it. They see their kids understanding things that they never understood in math, and they see their kids enjoying math. A middle-school principal came to talk to the elementary teachers when we were making the elementary adoption recommendation. He believed strongly in the very rigorous old-style math until he saw kids coming out of math class saying, "This is my favorite class," and "I really love this." He realized that this is what needed to happen. If kids understand math, they will enjoy it. Other principals have told me that there are fewer problems in math classes than ever before. They don't have to worry about controlling the kids' behavior because the kids are interested in what they're doing. They are more on-task than ever before.

I can't say that every student is happy. There are some students who can do a lot of computation problems quickly. They're now a little uncomfortable in 6th grade because they are no longer considered whiz kids and they are having trouble changing the way they think about math. But I can tell you that the teachers say that the kids, as a whole, are more successful and much happier than they were before. We still struggle with the question of what kids need to know in terms of straight computation. Should computation always be within the context of a problem? Should kids be able to compute quickly? How quick is "quickly"? We don't have the answers, but we're getting closer.

Meeting the needs of all learners

CMP provides more access for kids who struggle with math. Before the adoption, if a student couldn't add, subtract, multiply, or divide, he would rarely be introduced to other interesting topics in math. But now our kids with special needs are getting a chance to learn important mathematical concepts. They can approach data and some of the background for algebra and they certainly can enjoy geom-

etry. It's exciting that they are being exposed to a wider variety of ideas and are able to see more of the beauty of mathematics.

Because this is such a rich curriculum, it's almost impossible to teach all of the units. If a small group of students advances more quickly than the rest of the class, additional CMP units are easily accessible so the teacher doesn't have to create extra lessons.

No program will meet the needs of every student, but CMP comes closer than any other program we've used. I've observed classrooms and it's a whole different world out there than it was three years ago. I see very little off-task behavior. I see kids very, very engaged. We have far more kids excited about math and saying math is their favorite class. We're holding on to our kids longer in math at the high school level. The number of students who registered for math courses used to take a big dive after the two credits required for graduation. Now, students choose to enroll in additional math courses because they are mentally engaged in what is going on. If students want to be in the class, half of the battle is won. We're not there yet, but we're making some headway—and we know the effort is worth it. I think this is just a wonderful program. It's hard not to be excited about a program when you go into a classroom and see that teachers feel successful because kids are learning to make sense out of mathematics. ■

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