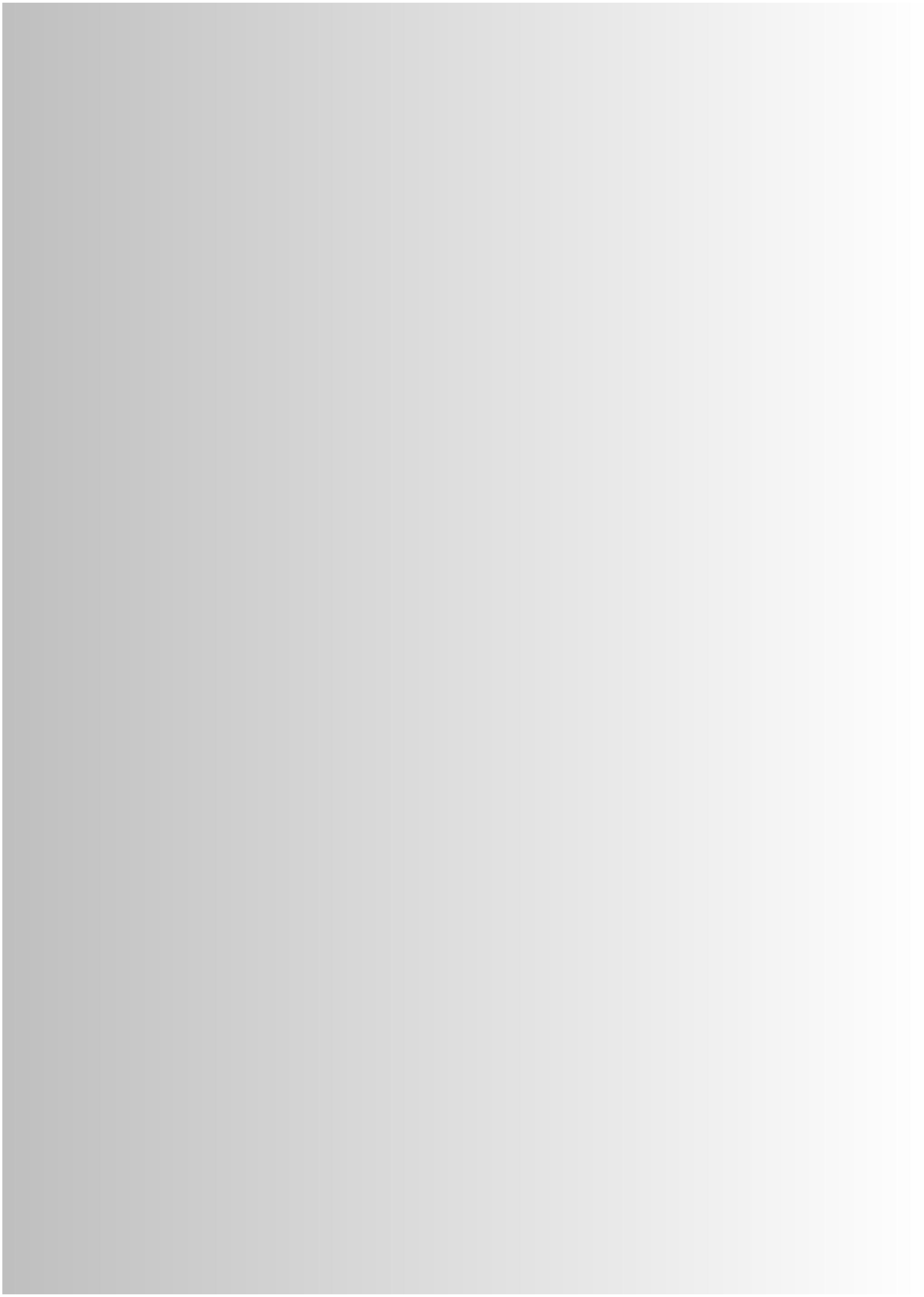
SIMMS INTEGRATED MATHEMATICS



SIMMS INTEGRATED MATHEMATICS

A high school curriculum for grades 9–12, developed by the Systemic Initiative for Montana Mathematics and Science (SIMMS).

SIMMS Integrated Mathematics (SIMMS IM) is a complete 9–12 mathematics curriculum that uses real-world contexts in an integrated approach for all students. It is designed to replace all secondary mathematics courses, with the possible exception of advanced placement courses. SIMMS IM considers mathematical topics in a different order than in a traditional curriculum, and teaches some mathematical topics not usually encountered at the high school level. The curriculum includes work in algebra, geometry, trigonometry, analysis, statistics, probability, matrices, and data analysis, as well as less traditional high school topics such as graph theory, game theory, and chaos theory.

SIMMS IM materials are partitioned into six levels; each level is a year's worth of material. All students take Levels 1 and 2 as a core curriculum. In the third and fourth years, SIMMS IM offers a choice of options. Level 3 is suitable for all students; Level 4 is intended for those planning careers in mathematics or science. Levels 5 and 6 offer options for students in the fourth year: Level 5 focuses more specifically on applications from business and the social sciences; Level 6 materials continue the presentation of mathematics through applied contexts while embracing a broader mathematical perspective. Each year-long level contains 13–16 modules; each module takes between two and three weeks.

SIMMS IM invites the use of a variety of instructional formats, including individual and cooperative group work, whole-class discussions, and individual and group projects. Each module has a central theme, and includes 3–4 activities. The activities use hands-on explorations, discussions, and assignments to guide students to a common understanding of the mathematics within it. "Mathematics Notes" sections in the text furnish students with definitions, symbolism, and appropriate examples. Additional features of the curriculum include research projects and brief sets of problems called "flashbacks" for additional practice of procedural skills.

Assessment materials—including alternative assessments that emphasize writing and logical argument—are an integral part of the curriculum. Suggested assessment items for use with a standard rubric are identified in all teacher editions. Assessment is an integral part of the Exploration, Discussion, Assignment, and Flashback sections of every module. In addition, each module has a Summary Assessment that is open-ended and often project-oriented, as well as a Module Assessment.

Technology is an important part of the SIMMS IM curriculum. Students must have ready access to the functionality of a graphing utility, spreadsheet-like features, geometric visualization, a statistics program, a symbolic manipulator, and a word processor (a graphing calculator such as the TI-92 has all of these functions). In addition, students should have access to a science-interface device (such as Texas Instruments' CBL (Calculator-Based Laboratory)™) that allows for electronic data collection from classroom experiments.

SIMMS IM student materials are available in three non-consumable, softcover volumes for each grade level. Teachers' editions correspond to the student materials: three softcover, non-consumable volumes at each grade level.

Publisher Contact

The publishing of SIMMS Integrated Mathematics is in transition. Please contact the Implementation Center for the most up-to-date information.

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JOHNNY LOTT ▸ DEVELOPER

Johnny Lott was a co-director of the SIMMS (Systemic Initiative for Montana Mathematics and Science) Project and the following *SIMMS Integrated Mathematics* Project. He is professor of mathematics and mathematics education in the Department of Mathematical Sciences at The University of Montana, where he has taught for the past 26 years. An active quilter, reader, writer, and antique buff, he is at home in Missoula with his wife Carolyn.

Dr. Lott received his formal education at Union University in Jackson, Tennessee (B.S., 1965), Emory University (M.A.T., 1969) and Georgia State University (Ph.D., 1973). He has taught all levels from grade 6 to university and has taught part-time in grades K–5. He is a past member of the Board of Directors of the National Council of Teachers of Mathematics and a former university department chair. He remains active in curriculum development and is currently the Project Manager for the Figure This! Campaign for the National Council of Teachers of Mathematics.

The development of SIMMS

For many years, our state has had an active state math council—the Montana Council of Teachers of Mathematics (MCTM). In the late 1980s, members of the council sat down with university people and asked, "What is it we should be doing next in this state, to help move secondary mathematics education along?" One of the strong philosophies that came out of that group was that high school mathematics should be integrated.

A small group of us then received a grant from the Exxon Education Foundation to begin looking at integrated mathematics, trying to decide what it meant to people across the country, and whether or not there was any interest in it. That work was the springboard for what eventually became the SIMMS curriculum. The National Science Foundation awarded MCTM a statewide systemic initiative in Montana that had, as one of its primary goals, developing a secondary school curriculum and implementing it. The SIMMS Project wasn't originally one of the official NSF curriculum projects—it grew as a part of the state systemic initiative. Because what we were doing was consistent with the other curriculum projects, it has been grouped with them, which makes sense.

We had the opportunity with this NSF grant to start from scratch—almost like some car companies do when they totally design a new car from the start. We started with a blank piece of paper. We got to really rethink what it is we ought to be doing in secondary mathematics. It was one of the more fascinating things I've ever worked on in my whole life.

In the beginning, we spent a lot of time looking at philosophies of teaching mathematics, philosophies of mathematics, and learning theory, and decided that, based on the 1989 NCTM *Standards*, we wanted a curriculum that had its roots in constructivism. We thought that the constructive, active way of learning was the way that mathematics should be taught, because in that way—at least it seemed to us—students would more readily accept it and learn it.

We also wanted a curriculum that was set in context: contexts from the real world, from science, even from mathematics in and of itself. We wanted a curriculum that could be used by all students. By all students, I don't mean just those who are interested in math and science, because the majority of kids who go on to further education don't major in math and science. We didn't want to ignore the potential math and science majors, by any stretch of the imagination, but we also wanted a curriculum that everybody could use. We decided that for the first two years of high school, all students, regardless of their interests, should have the same curriculum. Then after that, we thought that there should be options for what they wanted to do. We wanted students to have the right, with their parents, counselors and teachers, to make the decision for what mathematics they should take in their junior and senior years, based on their career goals. Another important tenet for us was that we wanted a curriculum that could be used on into the 21st century: we wanted a curriculum that made active use of technology. We made the decision early on that calculators and/or computers were necessary tools for learning mathematics.

We spent a lot of time talking with advisors about what mathematics should be in the curriculum. We had a national advisory board and a state advisory board. We interviewed lots of teachers—almost anyone who would talk to us—about what it would take to be mathematically literate if one took only two years of high school mathematics, and then quit. When you start out with that as a goal for the curriculum—to include in the first two years what it takes to be mathematically literate if you aren't going to take any more mathematics—your whole notion of what should be in the curriculum takes on a different flavor.

One of the somewhat flip but serious statements we heard was that for somebody to be mathematically literate, they should be able to read and understand the mathematics, and the graphs, that are in *USA Today*. Now, if you think about that, one of the things that you're into automatically is that your curriculum will have quite a bit of statistics, data analysis, and probability. It will have some algebra as well, but that first-year program will not look like the traditional 9th-grade algebra course.

When we were talking about geometry, we asked ourselves, what are the things that people use in geometry in the real world? That led us to thinking about similar triangles, and the Pythagorean theorem. Similar triangles get you into ratio and proportion. Some rudiments of trigonometry come up early on. There are areas and volumes that people need to deal with, even for something as simple as buying carpet for a floor. If you're talking about an oil slick in the ocean, most newspaper reporters report that as an area. However, there's volume there. We wanted students to understand things like that.

So these were the mathematical notions that were motivating us as we started trying to develop a curriculum for the first two years. Once we had decided on the mathematical ideas, we started looking for contexts where they made sense.

The curriculum was written by teachers. Between 24 and 48 teachers worked as writers on the program every summer. They worked in teams, writing each of the modules. Then the modules were edited and revised many, many times by other teachers, and then by professional editors. There were also some university people who worked on the program as writers, but by and large, the curriculum was written by teachers. The majority of the teachers were from Montana, but not all of them. We had a call for people from all over the country, and we did have writers from, really, all over the United States. We also hired a group of writers—these were teachers, too—during the school year. One of their jobs was to take the feedback from the teachers testing the early versions of the curriculum in their schools, and to use it to revise and rewrite the modules.

The structure of SIMMS

We wrote the curriculum in six levels. Every student takes Levels 1 and 2, usually in 9th and 10th grades. Then, if a student were interested in mathematics and science fields, they would then go on to Levels 4 and 6 in 11th and 12th grades. If a student were interested in other kinds of areas, for example liberal arts or business, they'd go on to Levels 3 and 5. We wanted to allow crossovers from one course to another, especially in the third and fourth levels. Just because somebody decided at the 10th grade they didn't want a career in math and science, we didn't want to totally lock them out of those courses.

We thought, for junior year, there should be at least two different honest mathematical tracks available to students—and that students shouldn't be locked out of changing their minds in their senior year. One track (Levels 4 and 6) is for the people who want careers that are heavily involved with math and science. So in that track, you will find many of the more traditional topics—although they're still written in context, because we always thought that context should motivate what we're

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doing. The other track (Levels 3 and 5) has more of a liberal arts or business focus, with more social science contexts. Much of the mathematics had to be the same, especially at junior year, since we wanted people to be able to cross over courses.

Mathematics

Without a doubt, one of the strongest areas of SIMMS is the statistics strand, which runs throughout the whole program. We made a very concentrated effort to write statistics problems that students could understand, because we really think that statistics is an area that everybody needs to know something about. Statistics affect virtually every facet of life. Often, even the people who are interested in math and science careers don't get much preparation in statistics, unless they take an AP Statistics class or something similar. We looked at math majors on university campuses, and we found that many of them wandered through their courses without knowing much about statistics.

The curriculum starts with fairly simple notions of statistics. We look not only at means, medians, and modes, but also at how one interprets data, and lines of best fit. Many statisticians try to always reduce things to linear kinds of fits, simply because they're easier to understand. When you're doing that, you sometimes have to transform data; you may use logarithms or something like that to transform the data. That's a pretty high-powered example.

So we did spend a lot of time looking at this. We worried, for people who are going into the sciences, about chi-square tests, just for example. That test seems to be used frequently in the sciences. And when we interviewed science teachers, they said, of everything we could do in statistics, that would help them the most. So there's that in the curriculum.

Another area that I consider to be fairly strong—that we spent a lot of time developing—is the underpinnings and beginning notions of calculus, even for very young students. We thought that even if people don't take any math beyond 10th grade, say, they should still have some notion of what infinity means, and what an infinite process is. We thought they should at least have the opportunity to get involved using a computer and seeing an infinite loop. We have the rudiments of limits early on, so that if kids were only going to take two years of high school math, they would get some of it. Obviously, if they were going on to do more mathematics, they would get more of it. When students are measuring things—even early in the program—we talk about approximations and precision. If you want to be this accurate in your overall final product, then how precise do you have to be in some of the pieces of it?

One thing that we tried very hard to include in the curriculum—and wound up not including—was a unit on fractals. It was actually written three or four times, and tried with students, but we couldn't get it written to the point that we thought it was mathematically honest enough. We could develop it to the point that students and teachers could all understand it, but then there was always something that was not quite honest about it—that was not quite true, mathematically speaking. It's a very difficult topic. You can approach it on a superficial level, and draw pretty pictures. But when you get beyond that mathematically, it gets much harder to do. So that was one unit that, although it was written several times, never got included.

In the SIMMS project, virtually every traditional algebra concept is taught. They're not taught the way they would be in traditional books. We do, for example, have units that involve factoring. In traditional books, factoring appears in the

9th grade: you have to learn how to factor quadratics. In SIMMS, you don't find it at the 9th grade. Factoring shows up where we thought it made the most sense—in the 11th grade, when we want students to think about the zeros of polynomials. Then, factoring makes sense as a topic, because something's happening to the polynomial and the graph of that polynomial that they need to know something about. Our 9th and 10th graders, if they're hit with something where they need to do that algebra—which doesn't happen too often in our curriculum—could use a tool like the TI-92 to get those factors in a hurry. Later on, when they're looking, for example, at graphs of rational polynomials or asymptotes, the calculator is a less appropriate method, because then they really need to understand what's going on in that graph.

Developing technical skills

After our first year of development, our pre-pilot year, we decided to add what we called Flashbacks to the curriculum. The Flashbacks are sets of review or drill problems that could be used either as homework, practice, quizzes, or any way the teacher wanted to use them. We added them because teachers were afraid that students weren't getting enough practice on some of the computational skills.

All of our data says that our kids do just as well as others in terms of developing skills—even though we don't focus on all the skill-and-drill activities. We added the Flashbacks not because we felt the students needed them, but because we thought that it would make some teachers, as well as parents and administrators, more comfortable. Some of the developers didn't want it there; we wanted to force the teachers to recognize, "This is a different way of learning mathematics." But it's something that we've had to add, to help people be comfortable.

If there were anything that we maybe would have done more of, in hindsight, it probably would have been to include more drill on some of the classic algebraic notions. It's not that our students don't have those topics. We have found that by the time kids have finished the whole SIMMS program, there is very little difference in their skills from kids who had been in traditional programs, as measured by standardized tests. However, when we interviewed SIMMS students who are now in college, they didn't feel as comfortable with their skills as we would like for them to. Part of this has to do with the way college classes are taught. One of the things they told us over and over again is that in the SIMMS program they had really worked and discussed and talked about things—but in lectures on a college campus as freshmen, there wasn't much discussion. They wanted to feel more comfortable in the drills that they had to do in college classes.

Technology in SIMMS

We decided early on—and made it one of the tenets of the curriculum—that technology could and should be used to learn mathematics. From the very beginning of developing the program, we expected that it would use technology. We were pretty convinced, and still are, that in tomorrow's world, the technology will be such a part of life that we have an obligation to teach students how to use it. We also think it can help them learn mathematics.

We tell schools right up front that if they're going to use this curriculum, they are going to have to have the technology. We strongly recommend to those using the curriculum that every kid needs something with a capability similar to the TI-92. A mix of those types of calculators and computer programs is a great aid to learn-

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ing the mathematics. A school could get by in the early years of the curriculum with a fairly simple graphing calculator, a geometry utility program of some sort, and word-processing (with an equation editor, or something similar, in order for students to write about the mathematics). Beyond the early part of the program, you really need other tools; for example, a computer statistical package, or a calculator with statistical capabilities.

Obviously, there are schools that can't afford the technology. We've found, though, that even schools with a limited amount of money have managed the technology piece in innovative ways. Schools that have needed computers have used portable computers, stationing them on a cart and moving them from classroom to classroom. Some schools have encouraged kids to buy calculators—but if students couldn't afford them, the schools have also made them available through check-out in libraries. There have been many, many different innovative ways to think about the technology.

Professional development

Using this curriculum requires professional development for most teachers. One reason for that is that we have included math topics that teachers may have seen at some point, but they probably haven't seen them in a high-school setting. This is especially true of some of the statistics topics. It is also true, for example, of some of the uses of matrices that we include in 9th and 10th grade. So, just on the content alone, there's a lot of professional development that has to be done with the program.

We truly encourage teachers to become active learners while their students are learning. For example, we use tools like CBLs (Calculator-Based Laboratories) to set up experiments and to collect data. That means there's no automatic answer to some problems, no way to say for sure what a teacher is going to see. It depends so much on what data the students are getting. So, one of the things we try to tell teachers is, "Here is the mathematics that you want to pull out of this eventually—but it may not always happen the same way." That forces teachers into a very different mode; they don't automatically know every answer to everything. It puts them in the situation of being a learner, with the students. It really makes their job much harder. It's far easier to go with a traditional program, and say, "This is the way I do the quadratic formula. Here are some problems. Go do them." In this program, there's not an automatic best way to do something.

We have some "traveling" professional development opportunities: three one-week institutes that we take to a school. We've worked very hard to have teachers who've taught the curriculum be the ones who work with schools on these institutes. We've done a number of the institutes all over the country. We tell schools, "If you're going to use our curriculum with your classes, you need this professional development as a minimum to get started—and you're going to need follow-ups along the way." One of the institutes looks at integrated math using technology. That institute specifically uses the TI-92, and was developed with the Texas Instruments Corporation.

We also have a one-week methods institute. We talk and work with teachers on ideas like, "What does it mean to be a math teacher in more of a science-teacher mode, where your classroom kind of becomes a laboratory?" A lot of the institute is for the teachers to actually do some of these experiments and problems in the curriculum, to go through them as students would. In the summer, when we do teacher institutes on a university campus, we try also to put the teachers with a group of kids, so they actually could try these problems and experiments in a safe setting. Teachers can actually see the kids working on these problems, and see what might happen in their classrooms.

The third institute is on assessment, because if you're teaching in this mode, the traditional test should not be your only form of assessment. We talk with teachers about what other kinds of assessment might be used. We looked at a lot of open-ended kinds of problems that one could give kids, to get them to show us what they know, or what they could do in a different context using the same mathematics they'd been taught.

We think that teachers should experience those three institutes—technology, methods, and assessment—in order to start teaching the curriculum.

Implementation strategies

In the beginning, the curriculum was implemented all over the state of Montana, because it was part of the state's systemic initiative. Since then we've moved on to many other places across the country. We strongly encourage schools everywhere to have at least two teachers using the curriculum when they begin. If there's only one teacher in a school who's teaching SIMMS, that teacher is probably going to have a hard time—teachers need support to teach the program well. Sometimes this is difficult to do in small rural schools; in those situations, we've encouraged the math teacher to at least work with the science teacher on some things together, so that teacher would have somebody to talk to. We've also set up a kind of chat line where teachers can get help from other teachers around the country.

In bigger schools, you have the option of running parallel tracks, in which you can start on implementing SIMMS, but also keep the traditional program going. That approach has worked pretty well for some schools. If there are parents who are really opposed to integrated mathematics—as has happened in some parts of the country—then there is an option for them. A good thing to do—at least in the beginning—is to let people see that this new curriculum is not the work of the devil, and it's not going to destroy students. It's a good strategy.

In every situation, you've got to have the support of fellow teachers and administrators. That, of course, is true with any kind of curriculum, not just SIMMS. But when you're doing something that's non-traditional, you really need that kind of support. We've strongly encouraged schools and teachers to have meetings with parents before the program starts, to talk about it, show it to them, and let them know, "Here's some of what we're going to be doing. Here are some sample problems. This is what your child is going to be learning. This is what you're going to be seeing at home."

Grouping students

We consider somebody to be tracked if they're put in a class where they may not have control of the decision to be put there. Our program is not designed to track students. What we're saying is that the student, with the family, counselors, and teachers, should really sit down and talk about what the goals are for the student. And they make the decision about where the student should go, in terms of choices in the program.

We wanted to have options in the curriculum for students to cross over from one class to another if they chose to. That posed a challenge for us, especially in writ-

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ing the Level 3 and Level 4 curricula for junior year. We were using different contexts for the mathematics, but at that junior level, we wanted to make sure that the content was comparable. We didn't approach the material in the same way, but the bottom line was that the courses had to have a huge overlap in terms of mathematics, so that students would have all of the senior-year options available to them. The senior year options—Levels 5 and 6—are different. We didn't try to make the content comparable to the same degree, because the interest of the student going into science and math is different than that of a student going into social sciences.

Teachers and schools have done a variety of things in terms of grouping students. One of the more interesting experiments was in a fairly large high school in Helena, where they allowed anyone to be in an honors program if they identified themselves as an honors student. All the students were put together in one class, but the honors students could do assignments that were considered to be honors assignments. The teachers got together as a group early on and decided what the assignments would be. So the students were studying the same curriculum, in the same room, at the same time—but there were assignments that made them different. It was an interesting experiment that appeared to work.

Impact data

At this point in time, Montana doesn't have high-stakes tests. We have required testing at 4th, 8th, and 11th grades; but every school can choose its own kind of test. There are bounds, but they're using their own kinds of tests. Those tests aren't really what most states call high-stakes tests.

Since much of the initial use of the curriculum was in Montana, we knew we would need a way of collecting data about student performance on standardized tests. We had a national assessment committee that met with us and said, "You've got to have a standardized test of some kind. You need to start it in the 9th grade, and continue it until 12th grade. The PSAT is as good as anything else." So, we used the PSAT as a standardized test to test kids in the SIMMS program every year. It's a standardized test that we've used across the board. The PSAT is more closely correlated with more traditional curricula than with SIMMS, but we have found no significant difference between our students and any other students, in any year. A lot of colleges in Montana use ACT and SAT as placement tests for college freshman classes. The SAT and ACT scores in Montana have traditionally been very high, and we don't see a drop in scores if students studied the SIMMS curriculum. We haven't seen any differences on either the ACT or the SAT.

Another significant study—outside of Montana—is being done in El Paso. The data is preliminary at this point, but very promising. A set of schools in El Paso began experimenting with the SIMMS curriculum in 1997. Students were tested on the Texas state test (the Texas Assessment of Academic Skills) after being in the program for two years. The district made the decision that they would worry about test scores for students in this experimental program only in the second year instead of in the first year. It was pretty clear that in order to get all of the traditional algebra topics that were tested, it would take two years, since they would be learning other things in the integrated curriculum. The tests were given, and all the preliminary reports that we've seen have indicated that SIMMS kids' performance was tremendous. So the preliminary indications are that they've done very well on the high-stakes test in Texas. ■

CLAY BURKETT ▸ MATHEMATICS TEACHER

Goals for students

I think one of the big things is to prepare students to think mathematically. I have a lot of students who aren't going to go into math- or science-related fields. Even so, in order for them to be able to be productive citizens, to be able to vote on issues that involve mathematical thinking, I want them to be able to look and think and reason about things mathematically: "What's the trend going on? What's the pattern happening here?" For those who are college bound, I'd like to give them a good solid mathematical foundation. A lot of my students right now don't think they're going to go into anything mathematics- or science-oriented, but I would like them to have enough mathematics that they can change their minds later on and not be starting at ground zero.

Selecting SIMMS

Three or four of us from the Helena area were involved in the SIMMS project in different ways. I was a writer there for one year. Another teacher was a writer for three or four summers. A couple of teachers went through the teacher leader workshop for those who were going to help train other teachers in the district.

So we came back realizing that the SIMMS curriculum met the frameworks we had set forth as a district for a largely standards-based curriculum. The support was not there to go 100% SIMMS, but we did introduce it as a pilot and then the school board eventually approved it as a full-time curricular option for students. Our students could choose to take SIMMS or they could choose to take the traditional courses. If they chose to take the SIMMS, then there was a two-year commitment. In a sense, the first two years were replacements for Algebra I and Geometry, although the scope and the sequence are different. Students would have to take two years and then if they wanted to opt into a traditional Algebra II, they could, but they couldn't take one year and then jump to Geometry, because in that first year they had some algebra and some geometry.

The SIMMS curriculum

When the SIMMS developers started this project, they asked the question, "If a student is going to take two years of mathematics and that's it, then what mathematics would we like them to know? What mathematics would we like to have them exposed to?" And that's what they've built Levels 1 and 2 upon. This includes elements from traditional Algebra I and Geometry courses, some topics that normally aren't covered until an Algebra II (matrices, step functions), elements from probability and statistics, and then some other mathematics that isn't traditionally taught, like fair division and networks. They pretty much built a two-year curriculum based upon that premise. Then they followed that with thinking that a student who's going beyond the two years of mathematics is probably going to be a college-bound student. So they developed the rest of the curriculum in two different phases. One phase thinks about what the student who's going to go into math or science as a major will need to know; that was developed into their Levels 4 and 6. Level 4 is real similar in many ways to Algebra II, with also statistics and some probability and number theory. Level 6 is real similar to a precalculus class. Then the other option is Levels 3 and 5. Level 3 is about two-thirds review of concepts that have been covered before, but taught in a different context or applica-

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Helena High School is a four-year high school located in Helena, MT. The Helena School District has two high schools, which draw from two middle schools plus other rural-area feeder schools. There are roughly 3200–3300 high school students in the district. The city of Helena has a population of roughly 35,000–40,000, with very few minorities. The city is home to many professionals, and is urban, at least in comparison to other parts of Montana.

That is another strength of the curriculum—it was written as a spiraling curriculum where they'll pick up the topic and introduce it one year and the next year they'll apply it a little farther and then a little bit farther.

tion, and about one-third preview to get them ready for success at the next level. Level 5 is a course that's for a college-bound student who is not necessarily going to be a math or science or computer science major, but who wants to have a good foundation in business applications and statistics. That's kind of an overview of the whole curriculum.

At Helena High School, we have been using SIMMS IM for five years as full-time classes. Initially, we used some of the early modules in traditional classes. During the first year of implementation, we implemented Level 1 only; the second year we added Level 2. Over time, we've used all Levels 1 through 6, but we are currently teaching Levels 1, 2, 4, and 6.

Strengths of SIMMS

Problem-solving is definitely a major strength of the program. There are times when I teach certain algorithms and we do some practice, but mostly they're using math and problem-solving situations in real-life contexts. I consider the context to be like a hook to hang their memory on—in Algebra I, students may have learned a certain topic, like factoring, but the next year they had forgotten what they had done. With the SIMMS program, kids will learn a topic and, because it has a context and because it has an application, when they come back to it the next year, they remember what they did. Now, they might not be able to jump right back in and do everything they had done the year before, but you're able to pick up where they left off rather quickly and then take it to the next level.

That is another strength of the curriculum—it was written as a spiraling curriculum where they'll pick up the topic and introduce it one year and the next year they'll apply it a little farther and then a little bit farther. There's a spiraling introduction, development, and mastery levels occurring throughout the four years. You don't start a topic and expect them to have a certain thing mastered before you move on. They spiral back to it in another time, in another context, and take it to another level in ensuing modules and years. Students are exposed to a concept a number of times, and research has shown that that's one of the keys in learning.

Here's an example. The first year we do a neat thing on exponential growth. And then the next year, we come back and we do exponential decay, but we pick up with what we did and we run into a dilemma that we didn't know how to solve in the first year. The second year, we learn how to solve that. Then, we get another dilemma that we solve using the calculator. And then we come back to that in the third year in the Level 4 book and pick up that idea again. Only this time we do it in the context of logarithms. We come back to "Now remember last year when we got stuck here with this problem and the only method we had was to use the table or the graph on the calculator and then we estimated the solution? Well, now here's how we can solve that algebraically using logarithms that we've been studying."

The technology is also a strength, although it's very controversial. I don't think kids should be doing 10% of numbers on their calculators, but the calculators can be used as a valuable instructional tool to approach problems at more advanced levels at an earlier age. For instance, you may not have taught students how to do all the algebraic manipulations for a problem, but you can still approach the problem and look at the concepts behind it and use the calculator to make up for what they lack in advanced algebra skills. I think that's a strength, because you're introducing kids to real-life applications and real math concepts that, in the past, they wouldn't have gotten until they had taken years of algebra and calculus. The graphing calculators make that accessible to us now.

This summer I took a workshop, one of the T^3 (Teachers Teaching with Technology) workshops on teaching Advanced Placement Statistics with an applications-based approach. Afterwards, some of the SIMMS teachers got together and were talking about how everything in an AP Statistics course was covered if students took four years of the SIMMS curriculum. We've had reports back from kids who are now in college that they took their college-level statistics class for their major and did excellent. They said it was mostly review. One girl wrote that she got a 98% in the class and was the only one to get an A. So they're getting much more probability and statistics than in a traditional course. Of course that comes at the sacrifice of something—that's where the developers made the choice to do less of the algebraic manipulation and such. You can't have it all.

Skills development and practice

I think there does need to be more algebraic manipulation in places in the program, but I think the lack of it is somewhat due to the state of flux of the mathematics education community. As kids progress on to college, they can go into a math program that is like the SIMMS—very applications-oriented and technology-friendly and problem-based. Or they might wind up at a place where the mathematics curriculum hasn't changed and calculators are not allowed and everything has to be done by rote and algorithm and paper and pencil. So it becomes difficult to prepare kids for the next level when you don't know what that next level is going to look like for them. We have to decide the things that we would really like them to still be able to do by hand if they wind up in a program that's not technology-friendly or conceptually-based. There are times when I just pull in and say, "We're studying logarithms and we've been doing this neat stuff, but we need to do some practice with using the law of logarithms to do some manipulation." There have been times where we've been studying rational functions and I went ahead and taught them how to do polynomial long division, for example. I taught them how to do synthetic division even though, for the SIMMS curriculum, we're able to use the manipulator on the TI-92 calculator to divide out the polynomials. I still felt it was necessary to teach them how to do some of that stuff by hand.

I don't do an extensive amount of practice with my students. I teach them, we go over some examples and I give them a few to do, and get them to where they can do it. I wouldn't consider it mastery, but at least it's exposure, so that if they get into a situation where they're in one of these real traditional curriculums, they're not starting from scratch.

Pedagogy

SIMMS is a challenge to teach because it's not scripted. When you get into problem-solving, students are liable to come up with anything. This is my third year teaching Level 4, the junior-level curriculum. I can't specifically remember what we were doing, but a student came up with a way to solve a certain problem that hadn't been done before. That solution hadn't crossed my mind because you kind of get locked into thinking, "Well, this kind of problem you solve this way." But when you have students out there who haven't been locked into recognizing that this is a such-and-such kind of problem and applying the appropriate algorithm, then they come up with a variety of things. As the teacher, you have to be ready to explain why some things work and why some don't. The kids don't want to just know that that way works or that their way doesn't work—they want to know why. So, as the teacher, you have to be real confident with your mathematical ability, so you can roll with a lot of these punches. You also have to be able to say "I don't

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know," or "I'm not sure. I'll have to get back to you on that," or "I hadn't looked at it that way. I'm going to have to research that and come back to you with it."

You have to be able to turn over more responsibility to the students, and some students aren't ready to accept that responsibility. You have to know that you're not calling all the shots for what's going to go on in this classroom today—you do control behavior and aspects of the environment, but the students control a lot of their own learning. So you become the facilitator. You're popping into a group and looking at what they're doing and maybe offering a suggestion or asking an appropriate question and then moving along. You try not to force-feed them answers or a process for how to do the problem. Sure, there are times where you step out of that and go through a process with them. But there are also times where they ask you a question and you say, "Well, that's an excellent question. How are you going to solve that?" And you leave it in their court.

Assessment

For me, personally, the assessment is the biggest challenge with this program. I'm learning more and more about it, but it's still the thing that I know the least about in this whole process. How can I write good assessment questions? How can I really get at what students know and can do, and what they can't? How can I find out what their thinking processes are?

I recently gave an assessment problem that had to do with the formula for determining a payment on a loan, which is a fairly ugly exponential and rational formula. Some of the questions were fairly simple and some of them were fairly complex, and I had them do a multi-part question. Boy, some of the students really struggled, but it was good for them to have to wrestle with that question. Some of them weren't real pleased that such a difficult question was on the test, but it was an application, it was real, and they had access to the technology to use at appropriate times. They had to think through the things we learned and apply them to a different situation. It was a very positive experience.

The materials contain a variety of assessments. They have some more traditional things as well as some alternative things and projects. Because they really only have end-of-module assessments or research projects along the way, I've developed some quizzes that I use, also.

Professional development

Another important point to consider is that you need to educate not just your high school teachers about the curriculum, but also your middle school teachers, because they are preparing kids for high school. So it's important, as you're doing teacher in-service or if you're looking at materials, to have the middle school teachers involved so that they know what's going on.

Of course, the high school teachers also have to be involved. That doesn't mean you'll get 100% buy-in, but you're not going to get 100% buy-in on any textbook you adopt. You do need to have most of your teachers wanting to do this. I think a district would set itself up for failure if they just decided to adopt SIMMS without really preparing the teachers and without the teachers wanting to do it. You can't just pick this up and start teaching it; you have to do a significant amount of in-service.

As part of being a writer for SIMMS, there was, of course, a lot of professional development around cooperative learning, alternative assessment and technology. There was a lot of time for learning how to use the technology as tools for instruction rather than just punching buttons on a calculator. And we had multiple in-services on things like teaching with the SIMMS philosophy, how to approach teaching with the technology, and assessment.

The SIMMS teachers really like teaching it. A lot of our traditional teachers were just dead-set opposed to it from the beginning. Now, they're not ready to buy into SIMMS and wouldn't want to teach it, but they have at least progressed to the point where they recognize the value in doing these application-based things and some more of the problem-solving and the technology. So I have seen professional growth throughout the district. Everyone has moved more towards the *Standards* than we were, it's just that not everyone's at the same place. No matter what, SIMMS has challenged the status quo and challenged teachers to think about their teaching practices and what they're doing.

Student impact

I have students who really thrive with this type of teaching approach. Some students are not strong mathematically, but they continue to take the courses; I see that as a good sign. Nothing works for every kid, but I think the majority of the population that I teach tends to remember things better when they do things or discover things themselves. Since I've been involved in these reform projects, I've very much bought into the constructivist philosophy that when students construct their own learning and meaning, then they retain that much better. That's not to say that I don't use other methodologies, but I try to work in as many conceptual building activities as I can to help them understand what's going on rather than just how to do this.

When we surveyed our SIMMS kids who've graduated, we asked them what they were currently taking mathematically and how they felt they were prepared. We got a real variety of reports because some hadn't taken their first college math course yet. Some were taking real basic liberal arts level math courses. Some were taking calculus; some were taking computer science. The results of the survey are more positive than negative, and the negative results usually came from students who were in situations where they had to do a lot of algebra by hand, but their peers were struggling with the word problems, and the applications.

The fact that there is a lot of reading involved is a real challenge in the first couple of years. One thing I'm really impressed with is that by the junior year, these kids are able to sit down and attack a problem that has a paragraph or two of explanation before they actually do anything. In a traditional program, getting them to read three lines of directions is like pulling teeth, but these SIMMS kids will read through a paragraph or two in which they're introduced to a context, some numbers involved in the problem, and multi-level instructions. They're able to sit down and read through that and jump into the problem. That's very much like what they'll have to do in the real world. I'm in the process of doing taxes for my wife's home daycare business right now; there are multi-layers of instructions and references and cross-references that are the type of things we need to prepare kids to be able to do.

For some of our special needs kids, we have some collaboration classes where a special ed teacher is in the same room with the regular math teacher; it's a het-

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erogeneous mix of kids, regular students with some of the special needs students. We also have some pull-out programs for taking tests where, if they don't have a special needs teacher in a collaboration class, the special needs students can go to a lab for assistance in reading the test questions. That's mostly in the freshman and sophomore level; by their junior and senior years, they are able to sit down and dive into problems that are very complex in terms of directions and background. That's an outcome that I see as very desirable.

Enrollment

Since the philosophy of the curriculum is that all students can come in here and take this, we thought our classes would be a heterogeneous group of kids. But we found early on that there were some kids who just did not have enough basic arithmetic; there were some kids whom we did transfer out of the SIMMS into Prealgebra at the high-school level. In the traditional track we offer the Prealgebra/Algebra I/ Geometry/Algebra II-type curriculum, as well as honors courses.

I'd have to estimate that we've got about 10% of students enrolled in SIMMS. The enrollment has dropped off the last couple of years because of various factors, mostly having to do with public relations. One big factor is that they have recently begun to offer Algebra at the 8th grade. A lot of the top students who might enroll in the SIMMS at 9th grade are now taking Algebra in 8th grade and in 9th grade are jumping into Geometry or Honors Geometry. So, they're not going to enroll in Level 1 of SIMMS. That doesn't mean that kids aren't able or ready to take SIMMS, but it effectively shoots them out of having that as an option, because Level 1 and 2 are seen as the same curriculum as Algebra I and Geometry. So we would hear, "Well, I've already taken half of that. Why would I go back and do it again?" And at this point, they're not offering the SIMMS Level 1 at the 8th grade. We would have liked to see them offer both, but they didn't have the staff to teach Level 1 at 8th grade and nobody at that level really wanted it badly enough to pursue alternatives.

Building community support

Right from the outset, some of the old-time teachers said, "We don't believe in this. We don't think it's going to work. We wouldn't recommend it." When you have teachers who have been around the community for years, they've developed a reputation and some people listen to them. So a variety of different rumors abounded early on that were negative about the curriculum. It didn't seem to matter how many times you answered the questions; the same questions still were out there, like, "I heard colleges won't accept this." Also, I've had students tell me that teachers at the middle school say they won't sign off on anybody's enrollment sheet if they are going to sign up for SIMMS. Some people are just plain biased against it and don't even have an understanding of what it is.

On the other hand, we've had parents whose kids have gone through the curriculum who say, "This is wonderful. This has been so great for my child. Our other kids are going to take it." We've had some glowing reports. And then we've had one parent whose student did real poorly on a college entrance exam and who is being very negative, not taking into account some of the poor decisions that this student made at the end of his high school career. This parent happens to be a teacher in the district, so that doesn't help.

Our building administrator is very positive about SIMMS. I do not think he would support a SIMMS-only curriculum at our high school, but he's been very supportive of keeping the SIMMS program going. While there hasn't been a lot of help from people at the district level, they haven't been real negative about it either. We've had some turnover in superintendents and a variety of issues going on at the district level, so this probably hasn't been a high-priority item.

It may be more difficult to get a single curriculum adopted as your district curriculum, but I've read that there's a lot less headache later on if you can. By having the traditional and the SIMMS, it allows students who fail in one or the other to then lay blame on the curriculum and not have to accept any personal responsibility. And if a parent is unhappy with the results, then they lay blame on the curriculum rather than other possible factors, like the student, the parent, or the teacher. So my recommendation, even though I don't know that we could have done it here even if we had wanted to, is to attempt to have the program as your curriculum for the school or the district, rather than having two separate tracks. ■

SUE MOORE ▸ MATHEMATICS TEACHER

Sue Moore is a mathematics teacher at Polson High School in Polson, Montana. Early in her career, Sue taught grades 7–9 at a U.S. military school in England. For the past 16 years, Sue has been teaching high school. Through her involvement with the SIMMS program, Sue also has spent time traveling nationwide, presenting about and helping to train teachers new to the program.

Polson High School serves about 530 students in grades 9–12. It is one of five high schools located on the Flathead Indian Reservation; about 30% of its students are Native American. Much of the income in the area comes from tourism, with some white-collar industry.

For two years, Polson High School used SIMMS by incorporating partial modules into their traditional classes; they then began implementing Level 1 four years ago, adding Level 2 the following year, Level 4 the next year, and running Levels 1, 2, 4, and 6 last year.

Goals for students

My goal is that students will be able to make mathematically-informed decisions. I want them to be able to make a contribution to society, no matter what position they pursue, whether it's college or as a citizen in the work world. I want them to be able to go out and function and make good decisions and understand what's going on in the world and reason whether something is correct or not correct, use problem-solving and logical, mathematical reasoning. In my opinion, one of the most important things now with my students is to know statistics and probability because they're used everywhere. I also want them to be exposed to technology and know how to use it, and not be afraid of it.

Why SIMMS?

I was one of the ones that dug my feet in at first, saying, "I don't want to change. I've got all my overheads made out for my geometry class. I can go in, put my overhead up, the kids take notes, I give them a test, I close the door at 3:30 and leave the school, and I'm off to coaching." I really liked that; it was easy.

But Terry Souhrada, a math teacher at Polson High School who had taken a year's leave of absence to get his master's, came back and was really frustrated. "What are we doing with kids? They don't remember this stuff." Then he had an opportunity to become a director of the SIMMS project. We didn't know much about it, but we knew it was integrated and it was "real world" with technology—it sounded cool. So he'd come back and say, "Jeez, don't you guys think you ought to try this in some of your classes?" We thought it might be interesting because we really respected what he thought. The head of the math department wasn't ready to change anything, so Terry was the one who opened the door for us.

The basic goal of the program was to address the NCTM *Standards*. We knew our top kids were going to continue to do well no matter what we used, so we had to figure out what we could do for the whole range of kids. For the other kids who are more challenged by math, we said, "Let's get those kids some math they're really going to be able to use. And let's get them some success, some confidence." We wanted to make math applicable to all students, no matter what level.

Strengths of SIMMS

The number one strength of the program is the increased problem-solving that I see with my students. They can actually see where they're going to use this stuff. It builds excitement because they're on the technology and they're talking in the group. It's been exciting to stand in front of the classroom and just watch what's going on and listen to the kids' conversations going back and forth, to hear a student who would never have said boo in a traditional classroom, or probably would have just scraped by, become engaged and excited about this. The kids are like, "Oh, this is cool, let's try this!" You see the creativity that comes out of it.

For example, I was in the classroom and we were doing the Boxing module. I'd given an assessment and the assessment was for them to design a pizza box for one slice of pizza. It's really open-ended; we'd studied tiling, percent waste, and how to get the least amount of waste on a piece of cardboard. I put them in groups and gave them a choice of using computers, calculators, paper—anything in the room was open game. Within their groups they all had to agree and have reasons for their answer, and the mathematics had to be clearly projected.

So I was walking around the room listening to the different conversations and a Native American girl who hadn't really said much all of a sudden said, "I think we should do this. What would it look like here?" and the other people in the group just looked at her like they couldn't believe it. I got goose bumps, thinking, "This is great!" Then I went to the next group and they were thinking something totally different. I had six groups and five different answers that were all mathematically correct. It took me forever to grade. I had to think, "Now what are they thinking?" and I'd go through, "Yeah, that makes sense. Yeah, that works." It was great to see their confidence, no inhibitions. Instead of, "What if we get this wrong?" it was like, "Well, let's go this way." There are so many different things they could do and that were correct. That was—wow!

We do a project per quarter. This year in my senior class (Level 6) we were doing a binomial probability module called *Cards and Binos and Reels, Oh My!* We studied fair games, what determines whether a game is fair or not. So for the project, I said, "You have a choice, you can either do a research project or you can do a game simulation. If you do the research project, you can get on the Internet, find any game you want to know about, and give me all the information you can. The only requirement is that you have to have a mathematical summary of what the probabilities are of the game and how it works, and you have to show me whether it's a fair game or not. If you do your own simulation, that has to be part of it, too."

I had no idea what I'd get; I thought, "They're seniors, let them go." I had one kid bring in a game he built by putting these three pieces of board together. He put nails in it and made his own bino stat game, and he had a little tennis ball he dropped at the top and had it go down. He'd done all these experimental probabilities to show which one was the most likely to hit and showed the different payoffs and how they correlated with the probabilities. Another girl brought in a cup with a couple of dice and said, "On a computer it would go like this, but here's all I had." Another kid brought in just a really simple, baseball-oriented game. He'd flip a card and one was Sosa and one was McGuire. I just was like, "Where did you guys even come up with these?" It was pretty exciting.

The SIMMS program does statistics and probability really well, partly because of the flow through the modules. Freshman level they get some, second level they get some; it's revisited in such a nice way and built upon so that it really makes sense. The kids really have an "Aha!" when they do sampling. They had no idea that they could make this graph on the paper look like so many different ideas, or that they could really make it look deceiving. The kids are just struck, "Wow, this is really cool."

When I taught traditional geometry, I'd show them the theorems, do a proof, and then they'd practice on the problems and memorize the rules. Here, students learn it through applications. In trigonometry, they do it in the context of the Egyptian pyramids, and students learn the trig relationships of sine, cosine, and tangent. In the traditional classes, I teach them sine is opposite over hypotenuse, so they memorize the formula, but they never know where to plug and chug. In the *Integrated* classes, it makes more sense and so they understand better. In the angle relationships with polygons, there's a *Traditional Design* module where they figure out the angles from parallel lines and relationships there. Our physics teacher tells us that those kids are able to look at the spatial relationship and have a better understanding of it than traditional kids who just memorized the rules and looked at a couple problems.

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Whether or not these materials are what we continue to use forever, adopting them when we did pulled us all out of our comfort zone and encouraged us to look at some things in a new way.

It's been my experience at conferences and things that when people see the sampler and it says "computers and technology," they automatically think, "Oh, well, we can't do that." There's a misconception that SIMMS is really strongly dependent on computers. It is dependent on the TI-82 calculator or comparable, and having an Excel spreadsheet is a nice addition. The TI-92 is nice because you can use the geometry utility, but we would be able to do what we need to without computers and without the spreadsheet and geometry drawing utility.

Instructional approach

It's best for my students to know what's coming, to have an actual set pattern to set the expectations of the day. I tell them "This is what we're going to be doing," and I get them into a pre-activity. As I'm taking roll, they're doing four or five problems, going over the homework assignment, or if it's a continuation they just go in and start working. Then we do a hands-on activity—the *Integrated* materials really lend themselves to that—and towards the end is more discussion and time for them to work on their homework assignment. There are tips that come with the *Integrated* materials in terms of how to write rubrics and do assessment. That was helpful, and made it a lot easier.

My students sit at tables, in groups of three. Depending on how the groups work, I've also had them work with a partner and then I'll move them into groups of four. I find that when I can spread them out, they're not as likely to get into conversations that are off the topic. So I spread them out as far as I can to let them listen to what I'm saying, and then I move them into the groups they need to be working in. Sometimes I'll use changing groups as a way to start a group-building activity, like I'll give them geometric figures and say, as a group come up with this shape, and each person has a different piece. So that brings communication to the group process.

The biggest change has been going from a teacher-centered environment to student-centered. I use "student-centered" not meaning the students choose what they're going to learn or do for that day, but that students are talking more amongst themselves and I'm a facilitator. That's been a big stretch, but these materials have really forced that on me and brought me out of my comfort zone. I don't have to race through the stuff; instead I think, "This is going to be really important and it's going to be worth it, so just take your time." I'll sit down at the table and ask the kids "What do you think?" and get the dialogue going back and forth. I used to sit down with kids and tell them, "This step, this step, this step, get it?" But there was never any dialogue. I could go back five minutes later and maybe they got it, maybe they didn't. Even with this program, it's a continual question of time versus quality—"Can I afford to do this? Can I afford not to do this?"

Professional development

The *Integrated* program has made every teacher in our department much stronger. Whether or not these materials are what we continue to use forever, adopting them when we did pulled us all out of our comfort zone and encouraged us to look at some things in a new way and to take some risks in an area that wasn't hurting our kids—it was only helping them improve.

Each of us took at least a one-week seminar in the summer with a teacher leader before we started. They had a joint math/science team seminar that you could go to, too, so we had one teacher who did two summers, one on her own and one with the science teacher. As a group we also had a teacher from Kalispell come down and do a T^3 (Teachers Teaching with Technology) type of a workshop. Texas Instruments gave us each a calculator and this teacher taught us how to use the calculator; that's how we got TI-92s for each of the staff members. That's a great way to do it, use your Dwight D. Eisenhower funds to educate your staff as a whole and get equipment.

I was able to coordinate with the principal to have six hours in January go towards our professional development time. We met as a department and talked about curriculum. After our first year of SIMMS, when we were into Level 2, we said, "Okay, here's our Level 2 kids. What do we see as the strengths? Here's where they're really good. Here's where they're weak—so this year in Level 1, we're going to hit harder on these weak areas." For example, one of the things that came up in Level 2 was a module that involved inequalities. Our kids never got to that module in Level 1 that first year, so we had to get to that module in Level 1 the next year. We had the time to do that dialogue, and just go back and fill in the gaps. I think we have a pretty strong program now because of that. It's going to take more time, too. This year Terry's been in my classroom doing some observations, and he's going to have some feedback for me.

You really have to be organized because you have more manipulatives than you've ever had before. I have a whole new appreciation of science teachers and what they go through to set things up. You also have to have worked things through before class. Probably the biggest thing I've learned, is that if I haven't gone through a lesson before, a question will come up where I have to say, "Ah, I don't know." My kids know that if no one in the group knows the answer, then when they raise their hands, I'll come over and help. First thing I say is, "What have you guys talked about?" So now they're on task, they know what to expect. It's made me look at teaching in a different way. I've developed confidence that I can teach whatever I want to teach. It's just going to take more time in some of the areas. But it's a real freeing feeling, to be comfortable with saying, "I don't know, let's investigate" and letting the kids understand that I don't know everything and I'm not going to pretend to know everything.

In my first year teaching SIMMS, there were three teachers who each had one class of Level 1 and we talked about materials. That was another strength—the dialogue it created between members of our department. The math community has always been strong in Montana, but through this project I've met more math teachers, in the state and out of the state. I've really overcome a fear of "What if I don't know this? They're going to think I'm stupid!" Now I can say, "I don't have a clue. What do you think?" We learn from each other. Math colleagues have done that as much as the students have. It's really opened the avenues to more communication.

It also has fostered communication with other departments. We talk with the English department: "Here's what I'm telling my kids to do on these portfolios. What do you see? What do you use for rubrics?" And I had a science teacher who came in when we were doing the genetics module and said, "You're teaching my subject. You shouldn't be doing this." I said, "I'm not teaching the science, I'm just telling them how the math goes along with this." By the end of the year, when he got into the genetics module, those kids were ahead of the other ones and so he came back and said, "Whatever you did last year, do the same, just keep it the same."

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Implementation

One thing I think we did really well was go slow in implementing. We were really thorough with the process. When the project came out, I saw a lot of schools that just jumped in. They didn't do the background work, and as a result, after one year of chaos they dumped it, and that did more harm than it did good. I think we were real methodical in what we did; we went slowly, we did a couple modules with the traditional classes, and we did more education for ourselves. The SIMMS implementation grants came through and they started offering classes; four teachers from our math department went to a 10-week course. Every Wednesday we'd drive to a three-hour class on how the program worked, what the materials were. After that, I became more interested in the materials and applied to be a writer. Another teacher applied to be a teacher leader. We kept getting more involved, and as we got more involved, the excitement grew, and we wanted to start bringing things into our classes. We had one real negative person in the department, which was a strength because he made us really be methodical and cover all our bases and not get into trouble. We had people who were willing to take risks and spend the time.

Without grant money I don't think we would have been able to start the program the way we did. The NSF supplied the state of Montana with a $10 million grant to write the materials and implement the materials, and the state matched $5 million for technology money into the schools. We applied for a technology grant and got one of the biggest awards, a matching grant with our school district where we put in $30,000 and they matched $30,000. To do that we had to go to the school board and say, "Here's the money we're asking, here's what else we're getting from that, here's what the program is," and that process really started a long journey.

The number one thing I would do differently would be to look at what the program is going to look like over four years, not just year to year to year. We knew we were going to do three classes the first year, and we knew the next year we were going to take those three classes to Level 2 and add some more Level 1s. But every year in the spring it's been, "All right, now, how many classes are we going to have of this next year?" When it got to the upper Levels where kids have more electives to take and didn't have to take math, it got more difficult for scheduling. I ended up with a class of 14 and a class of 8 of Level 6 this year; the school wanted to dump the class of 8 but I said, "We committed to having four years of this program when they began as freshmen. We can't dump it. We just can't do that." If you're a huge school, like Billings or Helena High, you have more flexibility in your schedule, but for a school our size, we needed to plan better.

Students' growth

It's real interesting to see students' approaches. I am getting more and more aware of what I am doing and I ask more open-ended questions. The kids respond to that more. An advantage for them is that they feel more comfortable experimenting. The science teacher tells us the *Integrated* kids are more willing to keep trying new stuff—"Let's try this, let's try this!"—where traditional kids will basically say, "I don't know. What do I need to do?"

That first year I used to go to my colleague and say, "What are we doing to our kids? Are we doing the right thing?" Then later in class we'd work on a question and I'd come in and be so excited, "Wow, this is really cool! Look at what they just did! I would never have guessed this." They're getting this increased problem-solving, increased confidence, and all that, but there's still the fact that they don't know how to solve equations. Well, I had kids in traditional programs that didn't know how to solve equations either. I find that by the third year of *Integrated*, as the kids are solving equations, they don't want to know just the process, they want to know why, how come. It's like, "Don't just tell me how to do it. Why? Prove it to me," and they don't accept it if you don't tell them.

As I go through the materials, I see all students, male and female, struggling and getting confidence with it. I think the program does lend itself to keeping kids in math longer. The education that the SIMMS project did with equity issues made me think about whether I am calling on students equally. It also brought to light those questions of what I can do to encourage women to stay in mathematics longer. I was really excited because I saw some of our Native American students in the *Integrated* program staying in math longer. I think the materials really lend themselves to their interest level, by bringing in the housing model with Native American dwellings, or the traditional quilting design.

Transition from middle school

When we did the *Integrated* at the high school, our 8th grade teacher started the MATH*Thematics* (STEM) program. Our 7th grade teacher had been there for 35 years and was a traditionalist all the way; we found that worked okay, because kids coming from K–6 would all go to him and get basic skills, and then they'd go to the 8th grade, which was the STEM materials, and start getting into some problem-solving, and then go to high school.

One of the things we found is that when the kids hit the STEM materials, they decided it was harder than what they'd had at 7th grade, so they didn't want to take *Integrated Math* in high school. And that's the way our middle school teachers were talking about it in guiding the kids to choose high school math—"Did you like 7th grade or did you like 8th grade?" And that's what kids were basing their high school choice on—whatever was easiest for them, not necessarily what was best for them. So where we are now is that the middle school teachers are going to use the STEM in 7th and 8th grade. The new STEM materials have more of a traditional look with more drill and practice. I see it as being a really good mix and being a really good feeder program.

After the first year of the program, where classes were all heterogeneous and the split between *Integrated* and traditional was 50/50, the middle school started an Algebra I program. That took 25 top kids out of the *Integrated* program and immediately put them in the traditional. This is now the fourth year of Algebra I, and I think I've finally convinced them that either they offer both Algebra I and *Integrated* I, or else they don't do any of them, because it's just not fair to the program and I don't think the kids are getting the best math that they could get. The Algebra I kids go into the traditional class because their parents want them there or because they know how to study and memorize concepts. They go on into the traditional in high school and by the fourth year they drop out of math. Our whole goal of going to the *Integrated* was to keep kids in math longer. Next year they're not going to offer Algebra I in the 8th grade. Since the high school is across the street from the middle school, the kids can walk across to the high school and take either Algebra I or *Integrated* I, or they can wait until they get into high school and double up somewhere and still get to Calculus.

We really listened to what other school districts had done and what didn't work for them. One of the things we heard about that we copied was to have parent nights and parent education.

Supplementing the curriculum

Our last two years' classes have been weak because of what they had at middle school. So we've done a lot of remediation, just like we used to do in our traditional program. If we saw students were weak in an area, we'd spend more time in that area. That hasn't changed. Basically in Level 1 we supplement solving equations and integer operations, some of the basic algebra skills. In Level 2 we supplement polynomial properties and foil method, and introduce factoring. Although they do see that in Level 4, we think they need to see it earlier for their science classes.

Early on it was brought to the SIMMS project's attention that teachers really wanted more materials to help kids catch up. They did make some adjustments; they added what are called Flashbacks, to use as warm-up activities or as more practice problems. Because I do enough of my own supplementary materials, I don't see it necessarily as a problem, but I know other teachers who would like to have more resources, like a resource book with supplementary materials.

Because the materials were written by so many different writers, it's really interesting to see the different approaches of different writing groups. For the statistics modules, there were one or two main writers, and anybody you talk to just says, "These modules are easy to read, they're user-friendly, they're so much easier to follow and they make sense."

Communicating with stakeholders

When we were starting, an aspect we didn't really think about as a department was how this would affect the rest of the school. Our school is committed to what we call "essential learnings." We all sat down to talk about what it is that we want our students to be able to know and do in the 21st century. Then we talked to the community, looking at the question of what do those "essential learnings" involve, and explaining that the *Integrated* program lends itself totally to that.

There was a lot of animosity that the math department got a bunch of money, part of which was from grants, but our district still had to put up some money. The other departments were a little bent out of shape, but when they started seeing the advantages in how it was affecting their departments and finding that we could put some money towards science with equipment, things like that helped out. It's real important to look at the whole scope of it.

As we did more dialogue, a lot of it was personal relationship and public relations, like sitting down with the English teachers and saying, "Here's what we're doing. How can this tie in with what you're doing? What can we do to make it stronger?" They're like, "Oh, you're getting them to write? Oh, I love it." At the end of the year I'd bring in a portfolio and say, "Here's what the kids have done, and I really see a difference from the beginning of the year to the end just in the writing skills, so it's made me more aware of what you do." It wasn't just a one-unit thing; it was a question of what can we do for the whole school. So now people are supportive.

We really listened to what other school districts had done and what didn't work for them. One of the things we heard about that we copied was to have parent nights and parent education. You have to do so much PR with any type of new program, but it's well worth your time, and it's good PR for your school, too. As far as the community goes, we had some letters to the editor that could have been damaging. There's a school 30 miles away that had implemented the program badly—

they went too fast, dove into it headfirst, hadn't done the background—and it bombed. They blamed everything on the program. So letters to the editor came out in the valley about that school; well, obviously that's going to cause alarm for our students and parents. So we put the letter up, we read it to the kids, we gave our justification on each one of those points, and then I wrote a letter to the editor that addressed each of those concerns. Now in Polson I think people are just polite and respectful of other people's opinions; they're just like, "As long as I have this choice to do what my kids want, then that's fine." On the other hand, there are parents who come in and say, "My kids never liked math, and they're doing their math now." So there are a lot of parents who are really excited about it.

There were times when I've wondered, "Are we changing just for the sake of change? Are we looking to make this better for all students?" Some days I'd feel really great about it and other days I'd worry we were messing these kids up. Then I decided we're making them better, and we're improving what we do. Is there one exact right thing? Probably not. But in hindsight, if we had to do it all over again, I would do it without a doubt. So I try to tell people, whatever program you do, the end result—the thing you're looking at four years down the road—is the amount of growth in your staff, where you're headed and how much further along you're going to be. Whether we use these materials or not, I think whatever we do from this point on will continue to be an improvement. ■

JOYCE FLOWERS ▸ DIRECTOR OF CURRICULUM AND INSTRUCTION

Joyce Flowers is the director of Curriculum and Instruction in the Raymore-Peculiar (Ray-Pec) School District in suburban Kansas City, Missouri. She has been in her current role for two years; her prior experiences include 10 years teaching at the elementary level, 10 years as an elementary school principal, and two years opening a regional professional development center.

In the 1998–99 school year, the Ray-Pec School District began using the *Investigations* curriculum for grades K–5, *Connected Mathematics* for grades 6–8, and is gradually implementing the *SIMMS Integrated Mathematics* program in grades 9–12. The district is small, and in transition from mostly rural to more suburban. The two small towns of Raymore and Peculiar, Missouri joined to build a high school, middle school, and elementary school. The district has approximately 4000 students, most of whom come from middle-class, Caucasian, two-parent families. The district has an 11% poverty level (as defined by the reduced- or free-lunch program) as well as a small percentage of wealthier, "land-owning, horse-breeding" families.

Why SIMMS?

At the high school level, we examined all of the NSF programs, along with *Chicago Math*, *Glencoe*, and one other traditional text. We selected SIMMS because it scored highest on our rubric for evaluating curricula. Also, our teachers had been using it in some classes, and found that it required less reading. This was very much desired by our teachers.

We've just finished our first year of our gradual implementation of SIMMS. It has been a big, big, big undertaking. We are aware of the fact that, particularly from the middle school upward, it's recommended that you implement gradually. However, in the state of Missouri, we have a new accreditation system that requires that we show annual gains in test scores. The fact that the test is given in mathematics at grades 4, 8, and 10 is why we chose not to do gradual implementation with CMP (*Connected Mathematics*) in the middle school. We have to accrue a certain number of points on the performance rubric in order to pass the performance section of accreditation. We knew that our high school people would have the toughest challenges, because the SIMMS program is far more academically rigorous than anything we've ever used in high school before. So we knew we'd better allow a gradual implementation at the high school.

All of our children who are being tested in grade 10 next year will have been in one of the new curriculum programs for two years. So if we don't see the kinds of results that we're all hoping for, then it will be a big surprise. Although our 10th grade teachers did not use the SIMMS materials exclusively this year, we expect that those teaching styles and processes will have sneaked into the 10th-grade classes.

All eight of our math teachers at the high school voluntarily participated with 9th graders in the SIMMS material. They decided to do that as a team—they felt that it was a big enough change that they needed to pull together. So they voluntarily, all of them, opted to have at least one SIMMS class this year. And all of our math teachers below grade 9 are using one of the NSF projects. Our 8th graders who happen to be a year ahead of the other 8th graders are also using the SIMMS materials, so anybody who's getting algebra is getting integrated algebra through SIMMS. The traditional track is going away. It was present this past year in grades 10, 11, and 12, and it will be completely gone in grade 10 next year.

About SIMMS

The SIMMS program is problem-based learning. Even by the names of the modules, they are acquainting youngsters with real-time problems. There's a module on AIDS. The *Skeeters* module focuses on exponential growth. There's a module called *So You Want to Buy a Car*. These modules are intrinsically motivating to the youngsters. One that I watched, very early on in the year, was the one on boxing. The youngsters brought cereal boxes from home, and developed, in cooperative groups, a methodology to ascertain how much material was necessary to make that cereal box. They are using TI-92 calculators at the 9th-grade level. They're conjecturing and they're working in teams. These are the strengths that are very evident in the SIMMS program.

Learning to use the program is challenging. Our smart, well-educated parents, who wanted to be a part of their children's education, found it challenging to help at home, because the data are gathered in the classroom, and because much of the work is done in groups. So teachers had to learn how to assign homework. Teachers also had to learn how to pace themselves and trust that what wasn't completed—and the weaknesses they saw in their youngsters the first year—will go away in time because the program will spiral.

This first year of implementation was also our first year of block scheduling at the high school. The SIMMS lessons lend themselves better to 90-minute blocks. You can do the 15-minute direct instruction lecture on the algorithm, and you've got plenty of time for the kids to work in groups. And then you've got time at the end to debrief what worked and what didn't.

I think the SIMMS people were a little concerned about the fact that their math textbooks are slim and not hardbound. My kids take their math book when they go home, because it's not heavy. And you know, when I have to replace that math book because some kid lost it or a kid defaced it, it's going to cost me $9.95, as opposed to $35.

Professional development and support

We really did some good things by having gradual implementation of SIMMS. I wish that we had done gradual implementation in our middle school also, because it would have been easier on us. You see, when teachers abandon those old behaviors, it's going to be messy for a while. The new behaviors are not elevated to the level of artistry yet. And so, as an administrator, you've got to support. I'm a K–12 curriculum director, but I've visited every math class in my high school.

We made certain that we had an external support system for ourselves. We have an organization in the state of Missouri called Success Link. They disseminated the information about the NSF projects; if it hadn't been for them, I wouldn't have known how to get a hold of all those projects, and how to make sure that all those textbooks were in the room when we were examining texts. We also used the SIMMS people, and used what we found to be a superior professional development model for our entire high school math department.

I made sure that my teachers had deep information about constructivist philosophy. We had two staff development days in November. We had two staff development days in March. We flew experienced SIMMS teachers in from Montana to do those training sessions. And the dissemination grant director for SIMMS was my mentor. He did two days' worth of lessons with our kids, and we videotaped those.

The state of Missouri has a Senate bill that requires us to spend a minimum of 1% of our general fund on professional development. If we don't, we lose our funding. It also requires that teachers be the decision-makers in professional development. So we used our staff development money. We also tried to build coalitions and partnerships, because we knew that we had to fully integrate what we were doing. So our partnerships are between my staff development director, who is also our assessment director, my professional development committees in each building, and my math instructional coaches. My math coaches received monthly training and coaching from a consultant. We used a Goals 2000 planning grant to create our district curriculum, scope and sequence, and assessment instruments. We partnered with SIMMS and their NSF dissemination grant. And we partnered with an A+ grant from the state of Missouri to make certain that we had a real-life focus.

During this year, teachers did not have common planning time as a department. However, each of them shared time with at least one other person who was a math

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teacher, so everybody had somebody they could commiserate with. In the March professional development for my math department, I watched my math teachers struggle with the math. I watched our newest teacher, who had just graduated from the math department in a wonderful university, be challenged. The math is harder. But you have to get your teachers to the point where they're confident with the math. And then, probably the toughest thing of all, they have to be confident enough to not tell the kids the answer, and instead allow them to arrive at an answer.

The math teachers in a high school are not used to gathering up materials for a math lesson. This was another way it was helpful to have those math coaches. Before school started, the math coaches got together all the materials and put them in the math office. I've learned from experience that you can't expect teachers who are trying to change their behavior to also go out and collect boxes for the cereal module, because they interpret that as non-support.

Tracking

This year, my teachers in grade 7 and grade 8 and grade 9 asked to not have math tracks. That was a big surprise—I hadn't expected it to happen so quickly. In the past, we have had a very tracked school system, where we had probably four or five different tracks in our high school. They said, "We cannot continue to segregate the more able learners in classes, and still effect the kinds of changes that we know we want to effect. And more importantly, we can't continue to segregate those students who are less capable at this point, because we now see that they've got to learn from peers, in addition to their teachers."

Working with parents

Board members had been receiving a number of calls about, "What's this crazy thing that's going on? Is this 'new math'?" and were quite concerned. So we had a district-wide math night in November. From 4000 students, we had 300 parents come, K–12. We had 15 different simultaneous sessions, K through 9. My job was to present the TIMSS (Third International Mathematics and Science Study) research in a way that was customer-friendly, and then to present an example or two from the new state assessment instrument, and some parallel examples from a SIMMS module. The teachers in our district who volunteered to participate presented a lesson with hands-on materials and calculators, and the parents were students. That was hugely successful in helping parents to believe, and in helping those who were not believers to suspend judgment long enough for us to continue. I really believe that when another person is saying, "No, no, no," all they're really saying is "I don't have the same information you have." They simply need the information that helped you arrive at the conclusions you've reached.

The next stage was to chat with teachers about the data we collected during our math night. I took all those questions back to my principals, and we looked at them to identify some weak areas. We didn't know the answer to "How can parents help at home?" but we felt that we should help parents learn this program. One of the unspoken frustrations was that the math was too hard for them. So we hired a math tutor to be available to any parent on Wednesday nights. We insisted that if students were coming in for help, their parents accompany them. Also, I made certain that the TIMSS video was in every school library. We made sure that every principal had at least five excellent articles, and at least two wonderful Web sites to refer parents to.

Another time, two moms who are pivotal members of our community came to visit me after talking with a teacher and a building principal about the changes we were making in the math curriculum. One of them said to me, “I want my daughter to have the best academic preparation I can possibly provide. In the past, that has meant that she would be in the next class up, and that she would be in the traditional text.” She was worried because our rival district wasn’t doing anything like this. So I told her that a prestigious neighboring district had contacted us and wanted their teachers to come and visit our schools, that these are the kinds of changes that every school district wishes they could make. I promised her that her daughter was being very well prepared, that the math she was receiving is much harder.

Student achievement and assessment

Our attendance has gone up, even among those kids who weren’t attending regularly in the past. I went into one of the math classes, and asked the kids to just talk to me about the program. “How do you like it? How’s it going? Just tell me the truth.” One of the girls said, “Even if I don’t make it to my other classes, I’ve know I’ve got to get to my SIMMS class. I can’t just do it at home, because I’ve got to have the information that I gather from the other kids. I’ve got to have the data. If I’m not there, my group doesn’t have me, and that’s bad. I come back the next day, and they’re mad at me.”

My vantage point is the bigger picture. I see kids forming hypotheses and implementing them. I see them building a sense of efficacy in mathematics. At this time last year, when they were in the performance portions of that assessment instrument, the kids spent about 50 minutes per session. This year, they spent twice that amount of time. Now, that’s important, because I know that they persisted.

We are looking for performance from our students; we are not looking for mere knowledge. We want the students to know when to use a specific formula in a given real-life situation. We want them to be able to conjecture and to think mathematically. We have our mastery scope and sequence for each grade level in mathematics on our Web site. We’re developing assessments this summer to parallel our state assessment instrument. You have to make it very clear what you’re after. We are aligning ourselves to the state assessment instrument because we believe that it’s a remarkable instrument. It’s very new, very progressive. One third is multiple choice. One third is constructed response, which is a question with five lines that the kids are supposed to fill in. The third part is performance events, a set of paper-and-pencil tasks for which students are given a scenario and several questions, and about three blank pieces of paper. So it lends itself to the kinds of reforms in mathematics that all of the NSF projects were based upon.

Our school district piloted the assessment. We helped the state by doing field testing in the fall, and then the following spring we voluntarily took the first tests. After the first year, it was mandated. This past spring, in April, we took that math test for the third time, and we’ll get our data in September. I will tell you that if our state test scores don’t change, there are going to be repercussions. I have to be able to put the data where my mouth is, or the push back will be hard and rapid. With the Missouri Assessment we have to show annual gain. We have to move three percent of the kids out of the lower two quintiles annually, and three percent of the kids into the upper two quintiles annually.

My vantage point is the bigger picture. I see kids forming hypotheses and implementing them. I see them building a sense of efficacy in mathematics.

Administrative changes

I meet with my building principals once a month, over a working lunch. We close the door and we just tell the truth. That's been very important. Administratively, I've outlined the fact that this stuff is harder. The kids' grades are not better, initially. The very best parents in the community were alarmed because they couldn't help at home. We have learned that you're going to undermine these kinds of programs if you don't have everybody on board. Teachers have to feel ownership of this, so as a policy, every single math teacher has to know that this has the full support of the school board, the superintendent, the director of curriculum, and every principal in the district. You have to have strong leadership. And the administration has to be well informed.

We've found that we had to relearn how to evaluate teachers. You see, the old teacher evaluation instruments are based on a "Madeline Hunter" model, where the administrator comes in and watches teacher behavior. But it isn't about the teacher behavior; it's about the student behavior. So you have to learn new ways to evaluate that. At our high school, we've piloted a new teacher evaluation instrument that builds in the question of student success. We've also begun to talk with teachers about the fact that we're going to eventually build a portion of the teacher evaluations around their students' achievements. ■