INTERACTIVE MATHEMATICS PROGRAM (IMP)

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A high school curriculum for grades 9–12, developed by the Interactive Mathematics Program (IMP).

The *Interactive Mathematics Program* (IMP) is a four-year curriculum of problem-based, integrated mathematics designed to replace the traditional Algebra I, Geometry, Algebra II/Trigonometry, Pre-calculus sequence. IMP integrates traditional mathematics with additional topics recommended by the NCTM *Curriculum and Evaluation Standards*, such as statistics, probability, discrete mathematics, and matrix algebra. By combining traditional concepts and newer material in an integrated setting, and by placing these ideas in meaningful contexts, the IMP curriculum meets the needs of both college-bound students and those headed directly into the workforce.

Most units begin with a central problem that students explore over the course of six to eight weeks. Some of these central problems are based on practical, real-world situations, such as maximizing profits for a business or studying population growth. Others are more fanciful, involving situations like a pennant race or a circus act. As students work through smaller problems in the unit, they develop the mathematical concepts and techniques they need to solve the central problem. A particular unit may combine several branches of mathematics so that students see how important ideas are related to one another.

There are three main types of student assignments in IMP: in-class activities, daily homework, and Problems of the Week (POWs). Students examine new concepts through in-class activities, working in groups and individually. Homework assignments reinforce and extend concepts introduced in class. POWs are open-ended problems, often mathematical classics, that cannot be solved easily in a very short period of time. In POW write-ups, students describe how they worked on the problem and explain their reasoning.

Each unit also includes a collection of supplemental problems, both to reinforce concepts and skills and to extend ideas beyond the basic curriculum. These problems provide a way to tailor the curriculum to meet the needs of individual students.

IMP requires the use of a graphing calculator during class. There are many IMP activities in which computer programs could provide valuable enrichment, but there are no activities that require computer use.

Teachers assess individual students in IMP using a variety of tools, including daily homework assignments, oral presentations, contributions to the group or whole-class discussions, Problems of the Week, in-class and take-home unit assessments, end-of-semester examinations, self-assessments, and portfolios.

Student materials for IMP are available in one hardcover textbook for each of the four years of the program. Accompanying *Teacher's Guides* are published in softcover for each of the units in a grade level. Additional teacher support materials include *Introduction and Implementation Strategies for the Interactive Mathematics Program*; the *Teaching Handbook for IMP: A Teacher-to-Teacher Guide*; *Baker's Choice—A Unit of High School Mathematics*; *It's All Write: A Writing Supplement for High School Mathematics*; and the *Guide to Using TI Calculators with IMP*.

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SHERRY FRASER ▸ DEVELOPER

The *Interactive Mathematics Program* (IMP) is a growing collaboration of mathematicians, teacher-educators, and teachers who have been working together since 1989. Sherry Fraser, one of the directors of IMP, taught the four-year curriculum to a heterogeneous group of high school students during the field test stage. Sherry is a former high-school mathematics teacher who taught for 15 years before joining the EQUALS staff at the Lawrence Hall of Science, University of California, Berkeley, where she developed and led workshops for K–12 teachers to improve the teaching and learning of mathematics.

Sherry is currently the director of the implementation center for the *Interactive Mathematics Program*.

Designing IMP

In 1989, the California Post-Secondary Education Commission requested proposals to develop mathematics curricula that would put thinking and reasoning at the core of the curriculum, and then wrap the concepts and skills of mathematics around it. The Commission represented all of the public and private colleges and universities in California. They were asking for an overhaul of the entire high-school math curriculum because they were getting students into their math classes—their Calculus classes, their Advanced Calculus classes—who were saying, "Just tell us what to do and we'll do it," and who had stopped thinking and reasoning about math.

At the time, I was working at the Lawrence Hall of Science at UC Berkeley with the EQUALS program, and we had been trying to increase the enrollment of female and minority students in math education for 15 years. When the other developers and I first saw the request, we thought, "Here is an opportunity to start from scratch, and design a curriculum for high school kids that would really meet the needs of today, and hopefully prepare kids for the future." We decided to apply for this particular grant. Our goals from the very beginning were to make thinking and reasoning the core of the curriculum; to make the curriculum accessible to all students in high school, instead of just the select few; and to include mathematics that was current and relevant, as well as mathematics that we knew needed to be there because it had traditionally been there. We wanted to put the focus on the ideas of mathematics, and introduce concepts and skills in a way in which they were motivated by solving larger problems from bigger ideas in math. Our goal is to have more kids like and do mathematics, understand mathematics, and be able to use it in their lives. So, we originally got started through that particular grant. Later on, we received funding from the National Science Foundation that allowed us to go back through the curriculum and rewrite it; to modify, enrich, and extend the curriculum.

There were four people—Diane Resek and Dan Fendel, mathematics professors at San Francisco State University, and Lynne Alper and myself, teacher educators at Berkeley, who had been working with high schools for many years—who came together to develop the curriculum. The four of us got together with six teachers—two from an inner-city area, two from an urban area, and two from a rural area. The 10 of us really designed this curriculum. The directors met every single week for 10 years, and we personally taught the curriculum at the same time as we were developing it.

We were designing a curriculum for real kids. Together, we were teaching a hundred kids at each of three high schools. The feedback we got about the curriculum came not only from the developers themselves, but also from the teachers and from the students who were involved. Students and teachers have always been part of the development process and the revisions we made in the curriculum. We really wanted to design a curriculum that made sense for students and teachers—and we didn't put anything in it that didn't make sense. Every homework assignment, every classroom activity, every problem of the week, every extension, and every reinforcement is there for a reason.

We used the 1989 NCTM *Standards*, and the expectations for University of California freshmen in California, as core indicators of the concepts and skills we

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really needed to be concerned about. These were the concepts and skills that were expected nationally and locally. We also tried to look at the bigger ideas, to clump those skills into strands that make sense. We knew that we had four years to develop the ideas in those strands. How could we introduce those strands in the 9th-grade year, and then come back and build on the learning experience each year, in each of the strands? That was our content goal.

We brainstormed all sorts of situations that we thought teenagers might be interested in, that could serve as contexts for each of the units of the program. We then looked at those contexts to see what we really could use to design a four- to six-week unit, and then which mathematical ideas fit in which context. For example, for a given context, could we introduce some geometry and algebra concepts, and also get involved with statistics and other things at the same time—all within a context of solving a larger problem?

We didn't design IMP with the hope that it would be around forever. Hopefully, 10 years from now, there will be curricula that are much better, and that build on the ideas of today. In 2010, I hope we can all say, "Oh, remember that IMP curriculum? That was really good but look at what we have now."

The mathematics of IMP

We tried to design a curriculum that we wished we had had when we were in school, that would have challenged us. All of us majored in math, but we really weren't challenged by it, because we just did what the teacher told us. We never really had the opportunity to sink our teeth into really rich mathematics until we were at least out of high school. I think even if we had to design the curriculum all over again, it would have pretty much the same curriculum in terms of the mathematics that's in there.

The curriculum is especially strong in some areas—for instance, in statistics. In 9th grade, there's a unit where students are introduced to normal distribution and standard deviation. I can say with confidence that after that unit, 9th graders understand those concepts better than I did after I finished graduate school. And they seem to retain that information, so that when the curriculum returns to looking at other tools in statistics, such as the chi-square statistic, kids can build on their ideas. I think we did a really nice job with the statistics strand. Most IMP kids are pretty prepared for AP Statistics. Students have told us that they're definitely prepared for the course, and they probably know 70% of the course before they even walk in.

I think IMP kids understand algebra much better. I think that is because all the formalism and abstraction isn't given to them in just one focused year in 9th grade. The ideas of algebra are developed first from a concrete basis, and then move to more formal levels of abstraction as we go through four years. The idea is that algebra is a tool that you can use throughout mathematics, in all areas of mathematics. It shouldn't stick out by itself in just one particular year; algebra is in all four years. I think kids leave the curriculum understanding algebra, and its role in mathematics.

Our biggest debates as developers were on what to do with some traditional areas of mathematics that we knew were not important but that were perceived as important. For instance, our biggest debate was around the quadratic formula. Our feeling was that the quadratic formula is way over-emphasized in the traditional curriculum. It's only over-emphasized because it's been in the curriculum since before calculators were around, and the only way you could solve those problems

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back then was by using the formula. With the advent of calculators, and being able to look at a graphical approach or a numerical approach, the quadratic formula is less important. We had debates among ourselves for years over whether we should put it in, where we would put it in, how we would introduce it, and how we could put it in an appropriate context.

The same thing was true with factoring quadratics. Once again, this is a topic that we know gets six to eight weeks of instruction in a typical Algebra I course, but that is truly not important. Nobody factors quadratics, but it's school math. We thought that there might be something about it on the SATs—until we looked at the SATs and realized there are no questions about it. But still, we knew that it might show up on a traditional test. On that we compromised, and came up with what we felt was a semi-creative way to introduce factoring, and to include some of that traditional curriculum. If the curriculum were only for us, and we didn't have to really "market it" to the whole country, we wouldn't have it in there.

Developing skills

In developing IMP, we really believed that if kids understood what they were doing, and thought about what they were doing, that skill development would be the easy part. We felt that when you're in a classroom, you should take advantage of the fact that you have peers to work with, and a knowledgeable teacher, and you should be doing rich, interesting problems—not practicing a mindless skill over and over again.

Of course, we had to face all the very traditional tests. California this past year gave the SAT 9 test[1]—a traditional test—to all kids. The state also gave what is called an augmentation test to all students. The augmentation test, at the high school level, is straight symbol manipulation from the 1950s. You're not allowed to use a calculator on any of these tests.

When the test results came out, one school decided to do an analysis that involved about 500 kids. They found out, when they looked at comparable populations of kids, that the IMP kids did better on the SAT 9 in mathematics, in language, in writing, in science, and on the augmentation test of just symbol manipulation. They did significantly better than their peers. So here was something we didn't focus on at all—and we found out that if you know how to think about mathematics, you can do better than your peers on mindless tests as well as mindful ones.

Increasing access to mathematics

All the developers of IMP have been involved in equity issues in mathematics for over 20 years. Our belief was that a number of students were being shortchanged in mathematics. So as we designed this curriculum, we purposely wanted to see if we truly could design a curriculum for all kids. We found out that if you design a curriculum so that kids are working together on problems that are accessible at multiple levels, you really can have a heterogeneous group and meet the needs of all students. So one of the things that I would say the IMP curriculum does quite well is really deal with the access issue. We say that IMP is for the middle 95% of the student population. The extremes—the 2.5% at each end of the spectrum—also belong in the program, but they probably have special needs and need special support outside of IMP.

[1] Stanford Achievement Test.

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The strategies that we've designed within the curriculum help support access to the mathematics for all kids. Besides various strategies we offer for teachers to make it work within the classroom, the curriculum itself has, at the end of each unit, both supplemental activities and extension activities that are tied to key concepts in the unit. So, when a teacher gets to a particular spot, and finds that one student is still struggling with a mathematical idea that most of the class understands, that teacher could give reinforcement exercises to that student. If somebody really understands it and is pushing the envelope, they could give more extension exercises.

We think it's better for kids to be with their peers, and that all kids should be in the same math classroom. But heterogeneity is a hard sell. Many people in our society think, "I don't want my kids with those kids," or, "My child's always been in the top group." Often, kids have been tracked before high school, and all of a sudden they enter 9th grade and there are kids sitting side-by-side who haven't been together before. Students think, "Well, that kid couldn't do math in 5th grade. What's he doing in this class?" We've had to do a lot of homework with school districts, with parents, and with kids, helping them see clearly why we set it up this way, what the goals are, and why we think it works. Most of the schools, I would say, have bought into the philosophy, but not all of them. One school I know has three different tracks for students, and all tracks use IMP—they just do it at different rates. Our suggestion to them would be "Why have three tracks?" but we're not winning that argument. So the next best thing is, "Put everybody in the program, and if you have to do it at different rates, do it at different rates."

A related issue is 8th-grade Algebra. There is often a mindset that, "If my kid is going to college, she has to be in Algebra in 8th grade." I think the IMP curriculum is appropriate for 8th graders with a good mathematics background; but you also need 8th-grade teachers who are well-prepared mathematically. They need to go through in-service for the full program, not just the first year, because even though they might only teach the first year, if they don't know where those ideas are going in the second year, and the third year, and the fourth year, they can't do as good a job. We have encouraged those 8th-grade teachers using IMP to go through the four years of in-service training, to help themselves mathematically, and to make them better teachers of the first-year program.

Professional development

We knew as we were designing the curriculum that professional development would be very important. For the first five or six years of the program, the only way a school could get involved is if they promised to provide an extra professional development period for every teacher, just for the program. We insisted on that, because there were so many changes that were going to happen because of the design of the curriculum. We wanted teachers to have time every single day to sit down with their peers and talk about questions like: what happened? what would they do differently? how were they going to ask better questions? and how could they get kids to work better in groups?

Then we had to think about, "What do we do when it's published?" When the program was published we couldn't insist that schools provide extra professional development periods. One thing we did was try to make our *Teacher Guides* serve as professional development guides as well. The *Teacher Guides* talk about the underlying areas of mathematics that are imbedded in the curriculum. They talk about questions to ask, what you might expect from students, and what the assessments might look like.

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At the same time, we insist on a quite strong professional development package that goes with the program. We are fortunate enough to have a publisher who also insists on it. We have 10 major centers around the country that offer professional development, both in the summer and during the school year, and for classroom meetings and visits, family nights, and administrator nights. These centers support the teacher, and support the kids and the school in the change process, because it isn't easy.

In the first year of teaching IMP, there is a leap of faith that teachers have to take. Since they haven't taught the program before, they're not sure how everything fits. For example, they introduce algebra concepts, but they're not going to take them to the level of mastery they would have in the past. They don't realize they don't have to finish the Algebra I course in six weeks—kids are going to see it for four years. This idea of letting go of what we perceive as mastery is something that we really work on with teachers beginning in the first year. There's also new mathematics for teachers to learn. Most teachers haven't had much experience with statistics and probability, and some areas of algebra and geometry such as matrix algebra.

Two big issues for teachers in the first year are "How do I assess?" and, "How do I get kids to be productive group members?" They're also not sure of the appropriate balance of skill development and conceptual development. They're concerned because they've never taught this way before; there's this fear that they're cheating their students by doing something different than they have in the past.

After the first year, those areas for professional development change. Teachers become more interested in understanding deeper levels of mathematics, so that when they're teaching, say, the central limit theorem, they really understand it themselves. They want to be able to extend the ideas that are in the curriculum, instead of being at the exact same place the kids are.

What we try to do in the professional development is model what the classroom will look like. We really believe that if you experience it yourself, you're going to understand it much better. So we try to have the teachers actually become the students again, and go through that experience. At the same time, there are certain times when you need to talk teacher-to-teacher about what we're doing and why we're doing this. Participants in professional development really wear two hats—teacher and student—and they go back and forth.

Building support for IMP

We say it takes a year to get a school or a district really ready to even think about using IMP. There are so many more players that you need to involve than you originally think there might be, and you really have to do your homework before you begin. You have to have committed teachers who are interested in teaching the program—but that's not enough. Within the mathematics faculty, first of all, you've got to make sure that the department chair and the calculus teacher are behind the program. Whether they actually start teaching it the first year or not doesn't matter; but those two individuals are often perceived as the leaders of the mathematics department. If they're involved and supportive, you will find there's more support throughout the department and throughout the school.

You also have to do your homework with administrators, and let them know what the program is, why you might want a program like this in your school, and what benefits it might offer to the school and to the students. We found that it's very important to involve counselors. We forgot to include counselors when we first

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started and then realized that counselors have a tremendous impact on where children are placed in school, and what kinds of programs they're placed into. We then started doing workshops for counselors so they would be familiar with the program.

We worked with school boards, and made presentations to school boards. We've reached out to not only the parents in the community, but to the community at large, offering awareness nights so that parents and community members could come in and find out about the program. We've tried to give them as much information as possible—evaluation data and other types of information about the program—trying to build up the desire for this change.

We've found that if you can reach out to other departments in the school, it really helps. For instance, at our local school, not only does the science department know about the program, but so does the English department, and the social studies department. They're very excited about this type of mathematics, because they remember their own mathematics experiences in high school, which weren't necessarily positive. When they see a program like IMP where kids are interested in coming to class, actually not hating math but liking it, they can be very supportive.

You really have to think of everyone who is involved, and make sure that they're informed and supportive. It only takes one person to destroy it for you, to sabotage the program. We've found that sometimes you have to cut your losses. We have told schools, "You're really not ready to start this program." We have a sheet that's called "Beginning the Change Process" that describes what you can do to prepare for changing your math program before implementing IMP. We suggest, for instance, giving kids problems of the week, and having teachers meet and discuss the courses they currently teach. There's a lot you can do before you start the program to get ready.

Implementing IMP

When people call us and are interested in the program, the first thing we do is tell them to read the *Strategies and Implementation Guide*. In-house, we call that guide "The Hundred Schools Document." It is a compilation of all the questions asked by individuals in the first 100 schools that got involved with IMP—questions from kids, parents, teachers, administrators, and school board members. We really tried to lay out in that document all the issues that we thought they should know about. If they're still interested in IMP, the second thing we suggest they do is visit a school that is using the program, so they get some firsthand experience with it. We suggest they visit a school or district that's like their own, so that they can see how it works in a rural area or in a city, or wherever.

If they want to move forward with IMP, we try to find out where the interest is coming from—hopefully, it's coming from both the administration and the faculty. If only one of those groups is interested, then they have a lot of homework to do in-house before they can start something. You really need those two groups working hand-in-hand. If they are, then they can start with building awareness for the faculty, and for parents and kids.

We believe that the program is for all kids, but it's not for all teachers. We found out the hard way that you can't make people do what they don't want to do. They will sabotage it, and it's not worth it. There are a number of teachers who do not believe that all kids can learn math, that mathematics is more than just skills, or that kids might learn something by discussing mathematics among themselves and with you. We think that you have to offer a program other than IMP for those teachers.

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We want them to use the graphing calculator to really look at areas of mathematics—such as functions—from multiple perspectives.

There are usually three different groups of teachers in a school. There are the folks who are innovators, and are always looking for ways to improve the program. There are the teachers who are doing a good job, but who are going to wait and see what the innovators are doing and how it works before they're willing to try something new. Then there are teachers who are reluctant, and you have to prove to them that it works. As long as the reluctant people are only reluctant, and don't sabotage the program, you're okay. We suggest you start with the innovators, having them teach the program first, and they will bring along the next group; and then those two groups will bring along the third group.

Some schools have had success with the entire school switching over. Usually, they're small schools with a cohesive faculty that's worked together for a long time. They don't have a divided math department going into the program. They're successful because everyone wants to do it. Those situations are rare.

Our recommendation is for teachers to begin teaching Year 1 of the program. The following year, they should teach Year 2 of the program, and also teach Year 1 again—because repeating it really helps reinforce that experience. The following year, they would teach Year 3, and the year after that, Year 4.

Using technology

When we first started developing the curriculum, we decided that the program would be absolutely dependent on the graphing calculator for all classwork, but independent of it for homework. For homework, kids need to have a scientific calculator, but they don't necessarily have to have a graphing calculator.

We try to get kids to use calculators appropriately. We find a lot of kids will pick up a calculator to multiply something they can do in their head, and we don't want them doing that. We want them using the calculator to do calculations that are tedious, and that the calculator can do much faster and more accurately. We want them to use the graphing calculator to really look at areas of mathematics—such as functions—from multiple perspectives. Using the graphing calculator, they can look at a function algebraically, they can look at it graphically, they can look at it numerically through a table, and really get a better understanding of what functions are all about.

We're trying to use the calculator as a tool to extend their mathematical thinking. Standard deviation's a good example. When the curriculum first starts standard deviation—in the introduction to it and the conceptual development of it—it really makes sense to include what the standard deviation algorithm is. But memorizing the algorithm doesn't make any sense whatsoever. So after kids really understand standard deviation, and see the algorithm, and see where the various pieces of the algorithm come from, then they can just use the key on the graphing calculator to determine it. They know what the machine is doing. So the calculator is really to extend the thinking, and to do mathematics that you never could do before.

Originally, we also thought that we would have a lot of computer applications in the program. Since two of the developers were teaching at Berkeley High and trying the program out as we developed it, we tried out the computer applications, thinking, "If we can do it, everybody else can do it, too," because we had 43-minute class periods. It was an utter disaster. We would try to get to the computer lab and back, which never worked. We would try to drag four computers into the classroom. It was just a nightmare. So we decided that we wouldn't have computer applications be an integral part of the curriculum. Now it would be nice to

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go back and add some extensions that use the Geometer's Sketchpad[2], and some data analysis software for schools that have that technology available.

Studies on the impact of IMP

We have a lot of data on IMP. We had a separate evaluation component for five years while we were developing this curriculum, and there were a number of things we were interested in looking at. One was retention rates: Did kids stay in mathematics longer? We found that they did. Then we broke it down by gender and ethnicity, to see what happened for different groups, and we found that, across the board, kids stayed in mathematics longer. We also found that they got better grades—not only in mathematics, but in other subjects as well.

We also did an analysis of attitudes towards mathematics, comparing kids in IMP to kids in traditional programs. We found out that kids who have been through IMP saw mathematics as more useful—that it came from society, and helps society solve problems. All their attitudes around mathematics were much stronger: they felt more competent about mathematics, more confident in doing it, and could see themselves as risk-takers.

We then did a number of studies around the SATs—there are 15 or 20 studies done on SAT performance, some by us, but also by a lot of separate schools and districts. Across the board, in every single SAT comparison, the kids in IMP always did as well, if not better—and sometimes significantly better—on the SAT, both in the mathematics and the verbal. There is not one study where the IMP kids did worse.

We also wanted to study areas of mathematics where we thought IMP kids would do significantly better, and those studies were done by the Wisconsin Center for Education Research. For 9th grade we used statistics items from the Second International Mathematics Study and did a matched-pair analysis, and found that IMP students did significantly better in statistics than their peers. At the 10th-grade level, we gave open-ended problem-solving tests to kids, and found out that the IMP kids did significantly better. At the 11th grade, we used a university-level quantitative reasoning exam, and IMP kids did significantly better.

We've also done studies using data from the SAT 9, the New Standards Reference Exam, and other sources, and the data has been very positive. Anyone who needs more details from those studies should contact a regional IMP center—they are listed on the IMP website, at http://www.mathimp.org. ■

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[2] Geometer's Sketchpad is an interactive geometry software environment that allows students to manipulate geometric objects on the computer. It is published by Key Curriculum Press.

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KAREN WEINAUG ▸ MATHEMATICS TEACHER/DEPARTMENT CHAIR

Karen Weinaug teaches at Vista High School in Vista, California. She has taught the *Interactive Mathematics Program* for six years, and has chaired Vista High's mathematics department for that same period of time. Karen has taught high school for 22 years in New York, Arizona, and at Vista High School, where she's been for the past nine years.

Vista High School is located north of San Diego. In the past decade, the area has changed from a rural farming community to become more suburban and residential. The town itself houses very little industry, but is surrounded by more industrial communities. Vista High School is one of four high schools in the district: another is also a comprehensive high school, one is an alternative high school, and one is a charter high school. The district serves roughly 26,000 students; Vista High School has about 3200 students. Socioeconomically, the majority of students come from families with low to middle incomes; just under half are Hispanic, half are Caucasian, and a small percentage of students' families are of Pacific Island, Asian, Filipino, and African origins.

Goals for students

I want my students to understand the root concepts of the mathematics. I really want them to be able to stand up and explain their mathematics and convince me they're right, based on correct mathematical work. I'm not one for memorizing rules and equations and formulas; if they can understand the process, they don't need the memorization. That's one reason why I love deriving the quadratic formula once they know how to complete the square. I say, "You don't need to memorize this formula, you can just do it all the time, because you know the process." It's so important for them to understand why it's working, because that answers their questions for them.

I would also like for my students to want to continue in mathematics and go on to higher-level mathematics. I don't want them to quit early because they don't like something or they weren't good at it. If they keep pushing themselves, they'll keep all their doors open for any career.

Why IMP?

One of the strengths of IMP is the combination of different methods of approaching problems. Having the kids know that they are responsible for standing up in front of a classroom and explaining their math puts the responsibility on the student, so they can't just copy from someone next to them.

Another strength is the POWs—Problems of the Week. They make the students delve into a concept deeper and deeper, encouraging perseverance. I watch my students learn that they can go back to their work and go deeper and fix it and work on it and have an ongoing working piece.

The basic approach of IMP encourages students to be responsible learners and not rely on the teacher just giving them information. The blend of the daily homework and the class activities also helps make this program work. I've seen other people try to pull out just POWs or just pull out the presentations, but they don't get that same atmosphere or see how it all fits together. When students learn about lateral surface area, they actually build these things and count cubes to see it, and then they develop rules from there. It's sort of like going back to elementary school, where the students were the learners, where the teachers let the kids figure it out. In IMP, my students are processing it and learning it for themselves, not because I'm telling them it's so.

Selecting IMP

Seven years ago, the department chair before me really opened the eyes of our math teachers with the NCTM *Standards*. As a department, we started looking at what we wanted kids to be able to do, and we came up with some goals. We wanted more students taking fourth-year math courses. We wanted our SAT and our PSAT scores to go up, because we were way below normal state and national averages.

We decided our traditional Algebra I was not doing it. Nine teachers in our department decided there were other kinds of math out there that we should look at. We looked at IMP and CPM (*College Preparatory Mathematics*). There were schools around us that had just started IMP and had just started CPM, so we started vis-

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iting them and just covered each other's classrooms for prep periods. In our block schedule we only have three classes a day, so this freed a teacher to go for the morning or the afternoon. Every math teacher went on an observation.

The schools around here were only doing the first year of each program, and we didn't feel that gave us a good overall picture. So the school gave us a staff development day for all of our teachers to go to a school in the Los Angeles area, where they had been doing IMP for two years. Once we saw the second year of IMP, we really wanted to see the whole curriculum. So we pooled our money to go to San Francisco, where it had been used the longest. We took 11 teachers, including a special ed teacher and a bilingual math person. Since we couldn't find schools that had our demographics, we split up into two groups: one visited a school in a high-income area whose students were almost all white, and the other visited a high school in inner-city San Francisco which had a lot of Hispanic and Asian students. We wanted to see whether it really worked for all kids.

We got to see Years 1–4 of IMP and then came back and compared notes. The unit in Year 3 that we saw was called *Small World Math*, where students were doing derivations. In every class we visited, kids were getting up in front of the class and explaining and doing presentations, which we had never done before. We were just amazed that these kids talked math. They weren't afraid of presenting mathematics, and were very respectful of each other.

Implementation

After looking at IMP, we all felt we would be able to accomplish our goals by using it. So then we decided that if Algebra were on the menu of courses, all the people would go to Algebra anyway because they know that word and they would not know IMP or *Interactive Math*. So we took Algebra off the menu—no one was allowed to go into Algebra as a freshman. They only had a choice of Math B, which is our remedial math class, and IMP 1. If students had Algebra I in 8th grade and could pass a test, they could still go into Honors Geometry/Trig, but that was the only avenue out of IMP. We felt so strongly about IMP that we said, "When you start, you stay in the program. You can't drop out unless you fail out."

These rules obviously caused some problems. So, as a first-year department chair, I permitted students to get into Algebra I if their parents had a meeting with me so that I could explain what IMP is and that we were doing real math. I made all the counselors come to these meetings, too, so that they could hear my spiel over and over again.

Starting the third year of our implementation, the assistant superintendent asked me to modify this strategy. We agreed to put a little disclaimer on the bottom of the registration form that says "For other course offerings, see your counselor." So if students didn't see Algebra I and they were looking for it, they at least could read that sentence and say, "Okay, I need to call the counselor." And some did.

Mathematics

When I taught traditional math, I hated teaching geometry. Now I realize I teach almost all geometry in Year 2 of IMP. I really love how they have an idea developed and then they expand on it. The unit in Year 2 called *Do Bees Build It Best?* takes a problem and goes from finding the area of any regular polygon with a given perimeter to finding the process to do that without memorizing any rules. Then they move it into three-dimensional space so that they can then find volume, lateral sur-

The basic approach of IMP encourages students to be responsible learners and not rely on the teacher just giving them information.

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I think the best learning comes from other students presenting what they did. When I have different students present the same problem in different ways, it always amazes me.

face area, and total surface area. So they extend one piece of knowledge to a three-dimensional object. The kids use trigonometry, geometry, and algebra in this unit.

I also love the statistics. They do the chi-square statistic in Year 2. Another favorite unit in Year 2 is *Cookies*, which is all linear programming and simultaneous equations, which students in my Algebra II class can't do. Linear programming and simultaneous equations are going to be used more in real life than just graphing one line. They graph two system equations in Year 2 and they use the substitution method. And then in Year 3, they not only go to two equations, but they go to 10 equations and they can graph it. They can graph in three dimensions and they learn matrices. Over three years of IMP, we solve simultaneous equations by graphing, and students go from graphing two lines to graphing inequalities of four.

Since there are no absolute value equations in IMP, we do supplement in Year 2. When we're doing the *Solve It* unit, we give them absolute value equations and inequalities to solve at the same time.

Classroom strategies

My teaching strategies have changed over the years. IMP did that to me. My students sit at tables in groups and we do a lot of visuals. Mostly there's little lecture, but there is some. I put students in situations where they're really trying to problem-solve and analyze to try to come up with the rules and equations and the patterns. Most of the concepts are approached in hands-on investigations from which students prove their thinking to the class. I think the best learning comes from other students presenting what they did. When I have different students present the same problem in different ways, it always amazes me. It's like a light bulb goes on—they say, "How did you figure that out? Oh, my goodness, I never thought of it that way." And then you analyze it yourself and say, "Well, it's true. You can look at it this way."

Changes for teachers

Individually, the biggest challenge was for me to change how I taught. I had taught 15 years of traditional math and I thought I was a good teacher. But this was a challenge and I am still working on different aspects of that change. I'm much more comfortable with the noise level now than I was six years ago. Somebody told me to listen to the noise—was I hearing good noise or bad noise? It was good noise, so that helped quite a bit.

I also had to learn to have faith that students will perform. It's hard to let them have the challenge and not interrupt them. When you go around from table to table and see the same mistake over and over again, you want to stop the class and have everybody look at you and tell them what to do. A big challenge individually for each teacher, I think, is not to do that, but to let them go ahead.

The other day I had a presentation in my Year 2 class where the girl presenting said, "I have no clue how we got these numbers." No one at the table did either. Then we had another group who had written every step down, very clearly. When they got done, I said to the first girl, "Okay, Katie, could you explain her overhead?" She could. So then we had discussions about what you need to do so that everybody understands when you're doing presentations. If you're on a test, don't you need the same thing for the teacher to understand what you're doing? Those kinds of discussions come out when you allow the students to fail and not think everybody has to have it right to go up and present.

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You have to be prepared to teach IMP. For Algebra II, I've always walked in and taught off the top of my head because I can do any problem in that book. There are times in IMP that you'd better not walk in without being prepared, because the questions that come up may not be the ones in the book, and you're going to have to deal with that somehow. Sometimes it's best to say, "I don't know. Does anybody else have a clue?"

Assessment

The biggest challenge for most teachers is the paperwork. IMP recommends not grading every single homework. We're finding that to be a real challenge in our department, because the kids perceive that it's not valued if it's not graded. It is frustrating to learn how to deal with the paper load of the POWs and the portfolio and the take-home tests all at the end of a unit.

Because we have so many classes, we grade the POWs holistically on a four-point rubric. We have to make sure that my four-point rubric and your four-point rubric are the same, so we use the collaboration period to do read-arounds. One person will bring in a class of POWs and all the teachers will grade it, and then we'll check to see if we all are grading it the same. On the items that we score differently, we'll discuss why. Then we actually formalize what are good As, Bs, Cs, and Ds, so that when you go back and grade your POWs, you know that four other teachers are grading theirs exactly the same way.

The other thing that we do is have common tests. We'll say, "Okay, everybody who's teaching IMP 1—if you want to make up the test, come to this room on Thursday after school. If you can't make it and you want certain concepts or problems on the test, write them up and give them to us." So everybody gives the same test on the same day.

Teaching both traditional and IMP, you really see the difference. Since 1991, we've had an assessment in our district called the Quality Math Assessment, which is the graduation exit exam for math. It is an open-ended prompt where students read the problem and then they write the solution, explaining their mathematics. All the teachers in the district score it on a rubric scale and it's always amazing to read them. Every year, people can tell which is an IMP paper because the writing is so clear and the explanation is always right there and you can follow the student's work.

Teacher support

When we decided to do IMP we realized that if you closed your door and taught without communicating with another teacher, you were not going to be as successful. So we made a commitment in our department that our prep period would be a collaboration period. The teachers who are teaching the same course have the same prep periods. Because of our block scheduling, we can do it one of two ways: the teachers of that period decide they're either going to meet all period for one day a week (that's an hour and 40 minutes), or they'll meet together for a half hour every time that period shows up.

We have a timeline for all 21 IMP 1 classes. Teachers have to be in similar places in the unit, because students may move from one class to another. We try to stay within one or two blocks of that timeline. So sometimes during that collaboration period we'll say, "Okay, we need to slow down here because so-and-so needs to catch up" or "You just need to go faster." And we adjust the timeline as we go.

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The collaboration also lets us know that if we do supplement anywhere, we're all doing the same thing. Our chemistry department came to us and said, "You guys don't do scientific notation and unit cancellation when we need it." So we move things around sometimes to accommodate our science department.

It's frustrating to set up the collaboration periods. I have to fight the administration not to move anybody's classes. But it's also a major plus because we get to communicate and set our agendas together. We share what works and what doesn't work in our classrooms, what are good homework problems and what should be done in class.

I asked that teachers get an extra prep period the first year they teach IMP, and we did. I also expected that every counselor and every administrator would support IMP; no counselor would use it as a dumping ground for low-level math students—it is a college prep course. My principal totally stood behind me when we chose not to advertise Algebra I as an option for 8th graders. He gave unequivocal support. Counselors, though, I had to work on. It would have been a much easier road if the counselors were in on it from the beginning and had a directive from the principal. The fact that our assistant superintendent in charge of curriculum had his kids enrolled in IMP was also a supportive statement.

Technology

When we first started with IMP, a challenge for us as a school was getting enough graphing calculators for every classroom. One reason why one school in our district said they did not go with IMP was because they couldn't afford the calculators. But we had a lot of fundraisers, and now, six years later, that school is amazed that we have graphing calculator sets in every teacher's classroom—and we have 20 classrooms! Another challenge for teachers is maintaining and managing the calculators and all the other manipulatives.

Parents

Parent concern wasn't a big hurdle for teachers, because, as department chair, I arranged to take the brunt of it myself. I met with and talked on millions of phone calls with parents. It takes time for me to go through everything with a parent. I show them that the tests are just like regular tests.

A couple of years ago, an organization that fundamentally disagrees with standards-based mathematics had some representation at one of our parent meetings. They passed literature from the Internet and parents started worrying. Supposedly, the letter said that one parent had written in claiming that Vista High had surveyed all of their IMP kids and had such bad-language feedback about IMP that they couldn't repeat it on the Web. The letter also claimed that the principal had said we were going to throw IMP out of the school. That never, ever occurred. I stopped the meeting and said, "Well, we need to clarify something. What we get off the Internet may not be always true. I have written to this organization's Web site. They refused to post me. I've had five students who tried to write in. The site refuses to post anything positive. They will only post the negative. And you don't even know if it's true." So we decided the Internet information was off-limits.

Serving different students

I think IMP prepares kids going into the workforce, because they can definitely think on their own. They may need a calculator as a tool, but they can think and

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reason. I think that's important. They can communicate. One of the reasons why local businesses picked IMP as the best practice last year was because we were teaching so many skills that they wanted their employees to know.

IMP absolutely prepares students to go into college math, as well. We have students that take IMP 1 freshman year, IMP 2, IMP 3, and go into Calculus and they function all right. We also have an honors option in our tutorial, where we supplement with vectors and some other precalculus skills. Last year we had about seven kids who went to Calculus. Now they're in college and they are all in Calculus of one form or another.

IMP serves a wide range of students. Our special ed is included in our regular mathematics program. We have some special ed teachers who went through IMP training; they have a study skills class where they can help the students. We have special ed students that have gone all the way through IMP 4. We also have a high population of ESL here. We have Year 1 of IMP in Spanish, where the materials and the teacher are both bilingual. Next year we'll do the same with IMP 2.

Student outcomes

You need to have indicators when you start IMP. If you don't have any numerical data, you won't have anything to compare to. Our SAT scores have gone way up. Parents need to see that kind of data.

Where we used to have problems with kids dropping out of math after sophomore year, we now have 89% of our whole student body taking math. From average SAT scores of 491 before, this year's seniors so far have an average of 543 on their SATs. We have over 50% of our kids scoring above a 50 on our PSATs. We have students who start in IMP 1 and go to IMP 2 and then IMP 3 and then are in Calculus, where, if they had started in Algebra I, they could have never made it to Calculus their senior year here.

We do supplement a tad bit for test practice. Our school has bought a county SAT program similar to the Princeton Review and we incorporate that throughout the junior year, Year 3. We're also now practicing some mental math and some warmups without calculators—kids who went to the community college were having trouble taking their placement exam, because our community colleges wouldn't let them use a calculator on it. It's easy to add skills to a concept-based program. It's hard to add the concepts and the problem solving to a skills-based program. ■

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RICHARD ROMAO ▸ MATHEMATICS TEACHER

Richard Romao teaches IMP at Wilbur Cross High School in New Haven, Connecticut. He's been using it for five years and has taught all four years of the program. Richard has been teaching at the high school level for 32 years.

New Haven is an urban district, equidistant from Boston and New York. Wilbur Cross High School is considered to be an inner-city school; it has approximately 1300 students and is one of six high schools in New Haven. Its student population is predominantly minorities, black and Hispanic. While many of the students come from families that are either unemployed or employed in blue-collar jobs, there are a small number of students from families who are economically comfortable.

Goals for students

I think of my goals for students in terms of making independent people who know how to solve problems—whether they be mathematical problems or any other kind of problems—and who have confidence in their own problem-solving abilities. I'm convinced that you can use the same techniques we think about and talk about for solving mathematical problems, to solve other problems that you face in life. We talk about that in class sometimes. Math is the vehicle that I use to communicate with children. I may not be as mathematically-oriented as other people, but I do have a loyalty to my students and what they're learning.

Why IMP?

A former New Haven teacher won a grant seven or eight years ago to pilot a mathematical project in the inner city. She told us she was willing to spend the grant on us if we were willing to pilot the *Interactive Mathematics Program*. Prior to IMP, we all taught the traditional Algebra I/Geometry/Algebra II sequence. We would have a lower-level sequence, too, where they did what was referred to as "applied mathematics"—the teacher would show the students what to do and then they'd solve problems, like balancing their checking accounts, writing checks, working with percentages.

The IMP program is a shift from everything we've ever done. It didn't appeal to too many of us at first. Originally, two people went out to California for the training and came back and implemented the first year. After the first year, one of those people didn't want to do it anymore; that's when I got involved. What intrigued me was the philosophy: that I would no longer be the focal point of the classroom, and the more I could remove myself as the focal point, the better the instruction would become. IMP struck a chord in me somewhere, to take the focus off me and make the kids understand that they were the most important part of the class, that what they were learning was more important than what I was teaching.

The basic approach of IMP is that, through a series of problem-solving activities, students are allowed to discover the various concepts in math which we used to tell them what they were doing and how to do it. Students used to just do the problems without understanding why. By some very ingenious problems in IMP, the kids are now allowed to discover what it is they can do and they do it themselves. From my experience, when they discover a concept, it has a much bigger impact on their memory than it did when I told it to them. They learn the concept without the mathematical trappings, and then you can tell them what the axiom is or what the postulate is or what terms they would have learned for this concept in other classes.

I had been teaching for 25 years, and it was becoming boring. Teaching any level of IMP never even comes close to being boring. The kids who generate ideas in the class are never the same. So if you listen to the kids and you take the class where the kids are going with it, it's a brand new course every year. Some kids might learn a concept one way and some kids may take the same concept another way. They're not going to learn the same thing from it, but they're going to learn equally important concepts depending on where they take it. Some kids take a concept and turn it into numbers, some kids take a concept and turn it into pic-

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tures, and some kids take a concept and turn it into relationships. As the teacher, you have to be prepared to go wherever they're going and use those vehicles to teach them, at least to make them understand and learn names for these concepts that they're thinking about.

Mathematics

IMP does a terrific job with solving systems of equations and graphing inequalities—they call it linear programming. I can remember when I was in high school, none of that ever made sense to me, and when I taught it traditionally, it never made sense to any of my students. But through the *Cookies* unit or the *Baker's Choice* unit in IMP, linear programming makes so much more sense for them. IMP also does a great job with slope, rates and change in rates; it's like an introduction to calculus where you're doing instantaneous speed and the change in rate. It is so much more real for them than just differentiating something.

I think that kids need exposure to some algebra before they get into IMP so that they have at least a working idea of equations. The kids who have a strong algebra foundation coming out of 8th grade are better able to make the transition into IMP and get more out of it.

On every unit that does geometry and trig, IMP does a great job introducing each concept. I'm doing a geometry unit right now that's called *Do Bees Build It Best?*, and what we're trying to find out is if the bees have the best design for their hives. The students experiment with a lot of designs and figure out area, volume, and things that work together. That leads us into circles, and into developing the area of a circle. It's discovery—students create everything they do themselves. There's so much more content in doing that kind of geometry than the postulates and theorems in Euclidean geometry.

Another strength of IMP is the idea that you can take the questions wherever you want—you're allowed to use your imagination in solving a math problem. Instead of being locked into a routine, locked into an algorithm, you're allowed to do anything you want as long as you can give some justification as to why you're doing it. I've had students just take a problem and make a brand new problem out of it. For instance, there's a problem where there's a camel that's going across the desert and the camel has to eat a banana for every mile it goes. I had one student rewrite the entire problem as on the desert plain at Dune, and he made the variable water. You had to walk from one place on the desert plain to another, and you were consuming so much water. That particular problem is open to an infinite number of solutions, and each kid gets to argue why their solution is the best, and how they did it. There are myriad ways to do it, from doing it mathematically to just guess-and-check random solutions.

Within each year of IMP, concepts are revisited. Different students get different amounts out of each lesson. I have to be patient and understand that they will get everything they can out of it right now, and that they're going to get another chance to develop this concept at a different level, in a different format.

Another strength of IMP is the idea that you can take the questions wherever you want—you're allowed to use your imagination in solving a math problem.

Changes for teachers

When students solve a problem in IMP, they have to explain everything—any assumptions they make, whatever they're doing. They have to develop their logic and they have to develop their problem from start to finish. This makes work for the teacher—as you obviously have to read the solution—and then it requires

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The first time you teach this it's like one foot is in quicksand and the other foot is firmly planted on a banana; you have no idea where you're going.

comments and sometimes a complete rewrite. Students have the ideas, but the ideas are sometimes all over the place. In class, the students model the problems together, but on individual papers sometimes they need some immediate structural support. The teacher has to take time to give that.

Prep time also becomes huge. Even though you're not creating the problems, when you're laying out what you're going to do in class, you have to create the space to do the problem in. You have to consider where the kids are and where they're going to go and what are the different steps to get there. The preparation that you're doing for class is more a prep for understanding where the problem could go, how many different interpretations or solutions students might have, how many guidelines should be put on the kids, how much freedom to give them, and how much direction to give them. That's always a challenge for me, figuring out where the kids are going to take a problem. If I can anticipate questions that I might get, then I'm better prepared to deal with those questions. The easiest thing to do is answer the question; the hardest thing to do is to ask students questions that might lead them where they have to go.

In the teacher's units of the IMP materials, there are some questions for the teacher to use to prompt classroom discussion. The teacher's unit is broken down into days and homework numbers and in-class lessons. It gives you an introduction to the lesson for yourself and it gives you some of the questions that might be pertinent to ask if the kids come in with certain types of responses.

IMP is much easier the second and third time around, by the way. The first time you teach this it's like one foot is in quicksand and the other foot is firmly planted on a banana; you have no idea where you're going. Preparation in the first year is immense; after that it does get easier. One of the other curious things is that when you're teaching it, the teachers who are teaching IMP get a lot closer, because you're constantly talking to each other and supporting each other.

Implementation challenges

The first year of IMP is an adjustment that our students do reticently. They don't want to think; they would rather be given busy classwork than have to solve problems within the class. Most of them, given the choice, would rather work alone than in groups. When they get to IMP and you give them a problem and say, "Solve it," and they say, "How?" and you say, "Figure it out," their first impulse is to just stop. The first year is the toughest year to teach, without a doubt.

Reading is one of our biggest problems. A 5th-grade reading level is a necessity. If students are left on their own to read and interpret the problem and then solve it, some of them won't know what the problem is. So we read each homework and classwork aloud, and then the students interpret it, to make sure that they understand what the question says. The curriculum itself does that, too. Students constantly have to rewrite problems in their own words.

Logistically, one of the hardest problems is transferring kids from program to program. If a student takes IMP and wants to switch out of it after a year, it's hard to know where to send him. Because IMP is integrated and doesn't deal with one topic unilaterally all year long, the student hasn't learned enough algebra to go to Algebra II, or enough geometry to go to college geometry. At the end of four years of IMP, IMP students know the same concepts that students in traditional programs know, but at the end of each particular year they're at a different level than the traditional students; there's no parallel movement in any other sequence. In

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terms of testing, they do have enough geometry and background in everything by the time they take the PSATs or the SATs.

Assessment and testing

At Wilbur Cross, we mostly follow the assessments in the books and most of the recommendations they make for assessment; that works out pretty well. Sometimes we create our own problems for a final exam or a midterm, or we slightly alter the existing assessments. The program has so many supplementary problems in each unit that you always have options to choose from.

The mastery test that we have in Connecticut is a performance-based test, so that's not a problem. Our kids do well on the SATs, so that hasn't been an issue either. I think the kids who take algebra in the 8th grade and then come to 9th grade and take IMP have a tendency to do a little better on the SATs. The SATs are still traditional-math-based questions, so the kids who have that traditional algebra exposure in the 8th grade seem to do a little better.

Heterogeneous groups

The fact that IMP insists on the classes being heterogeneously mixed is great. It makes everybody a better student, and makes students better people, because on the group work, they're graded as individuals and they're graded within their group. Everybody begins to develop a group responsibility as well as an individual responsibility.

However, constructing heterogeneous classes is the hardest part of implementing the program. Sometimes the classes don't come mixed—you'll get a class that's on a relatively high level, or a class that's on a relatively low level, and there isn't any mixture in between. I've found the ones that do get mixed work out a lot better because their work together elevates both the general-level student and the college-level student, and it does nothing to bring down the advanced-level student. It makes them all better students. They become teachers as well as students. If a student understands a problem first and explains it to his group, it makes his knowledge of it that much deeper.

There are lots of things that we do in class that are visual and spatial, and sometimes the lower-level kids get it faster than the upper-level kids because they think differently. Lots of my kids think in pictures as opposed to numbers. They're able to solve problems faster than the upper-level kids. In this way, the students earn respect from each other.

Probably more than any other program I've taught, IMP takes care of meeting the needs of all learners. Every student's not learning the same thing—I might have one student who's learning the lesson at face value and another student who is taking this lesson somewhere else, be it abstractly in pictures or diagrams, or even just in the ideas of where this is going and how it relates to other things. What students bring to the table determines what they take away from it. That helps everybody with problem-solving and working within certain constraints and parameters.

Technology and manipulatives

Although I'm basically calculator-phobic, I think using technology with this program is terrific, because it means that nobody has to spend hours and hours multiplying, dividing, adding, and subtracting. The kids love using the graphing cal-

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Each of us received at least one week of training in the summer—about five days for seven or eight hours—and then five Saturdays throughout the year for another eight hours each.

culators, so basically I give them an idea of what we're trying to do and then I let them experiment. Once they figure out how to use the graphing calculator to work on a problem, they can't wait to teach it to each other. That takes pressure off of me, so that I don't feel I have to be a calculator whiz. The book has enough instruction so that I can figure out what we're doing with the calculators and then set the students free.

For me, it's almost impossible to manage materials and manipulatives. I'm not the most organized person in the world, so things become quite chaotic when it comes to managing the materials. We, the IMP teachers, buy our own supplies, because our school never seems to have enough money for supplies. We're constantly lending them to each other, so that sometimes we don't even know which room the materials are in, never mind where they are. But it works out. I have never gotten to a point where I couldn't go on because I didn't have the materials. Still, managing the materials is definitely a challenge.

Professional development

If IMP is going to be brought into a school, I think all the math teachers in the school should be trained. Not everybody in the school has to be required to teach it, but I do think everyone should be exposed to the training so that everyone knows what's going on in those classes and everyone understands what the options are when students sign up for a math class. Everyone in the school needs to understand the idea that real math is going on in IMP. I also think that the 8th grades, the feeder schools, have to understand what IMP is, so that the teachers can make recommendations to their students. That's extremely important.

Each of us received at least one week of training in the summer—about five days for seven or eight hours—and then five Saturdays throughout the year for another eight hours each. So that's about 80 hours of training just in one year, to implement one year's program. The trainers modeled how to teach it and gave us some idea of what to expect. They went through each unit and highlighted certain activities in the unit that they felt were core activities. If there were 25 homework problems in a unit, we would skip around and do 10 of them. The trainers would have us model student activity while they modeled teacher activity. Being involved in the training as a learner helps so much. Put in that position, nobody wants to make presentations, nobody wants to get up in front of the group, nobody wants to admit when they're not sure they know something, nobody wants to ask questions because they don't want to sound stupid. When you go through that in the training and understand that you, as a teacher, had the same trepidation, you have better insight into students' behavior.

Resistance

Within my school, there's definite resistance to IMP. One of the reasons is because it's a lot of work. Correcting written solutions to problems and explanations and evaluations of problems rather than correcting bottom-line numbers is a lot harder and takes a long time. I wind up writing more on some papers than my students do.

When you teach IMP, your classroom always looks like it's out of control—the kids are mobile, they're talking all the time, and it's sometimes difficult to find the teacher. It doesn't look like what a classroom used to look like, and a lot of teachers resist that in favor of controlling the learning and the information.

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Some traditional teachers don't appreciate the amount of mathematics being taught in IMP because they really haven't seen the program in action. In fact, for three or four years the common idea was that IMP was remedial math. Those who have observed other IMP classes commented that "it was too much work." Only in the last couple of years, since one of the other teachers and I started doing workshops with 8th graders and 8th-grade teachers, have we started getting more people into IMP.

The hardest thing to do is teach IMP if you don't believe in it. The first year I taught IMP, I truly didn't know what the kids were learning. I believed what I was being told at workshops and training sessions, and that's why, as I proceeded with this class to each next level, I was amazed that I was learning as much from the students as I was learning from anybody who was training me. When we got to the end and looked back at what we did, there was just such an accomplishment and such an accumulation of math that they learned.

Community support

We're the only teachers and the only school in the entire district that are using IMP. In this school there are only three of us in the math department teaching IMP, and one of the bilingual math teachers also teaches it.

Our department no longer has a department head. Our last department head went to IMP training but didn't help or support those of us who were implementing the program. We do have a district math supervisor who has been trained in all four years of IMP. He understands how good it is and he understands the concepts, but he doesn't encourage it throughout the city. District-wide, everybody's talking about moving into problem-solving or problem-based or assessment-based learning. We call ourselves the best-kept secret in New Haven; nobody knows IMP is happening.

Publicity could change that by making people aware. We did a workshop for about 30 middle-school and high-school teachers on a small unit called *Baker's Choice*. They absolutely fell in love with it. But the problem was, there were very few high-school teachers there; most of them were middle-school teachers. We need high-school teachers to go to some workshops so that they can see the value in what we're doing; they need to be exposed to an entire unit to see how the unit is developed and what the kids wind up learning. This would take maybe 10 to 15 hours of workshops where we model what the teacher does and they model what the student does. Then, the high school teachers could actually see the development of an entire unit—where it starts, where it goes, what's required of the teacher and what's required of the students.

If IMP is going to be implemented by a community, then it needs to be at least on an equal basis with the traditional program. I don't think a student should be forced to take IMP; I think they should have a choice, because we don't all learn the same way. Some kids are so comfortable in that traditional setting that they absolutely cannot function in IMP, so that I don't think we should condemn anybody to any specific course of study or any specific ideology. However, I do think that every teacher should be trained in IMP, even if they don't teach it.

Parents

One of the reasons our IMP effort didn't die is because of the support we got from parents. Most of the students who take IMP have heard about it from somebody

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Then the kids run a workshop for the parents, where the parents become the students and the kids become the teachers. Those have been so successful. Parents are our best public relations.

else's parents, or from another student. In some families, the older brother or sister took IMP, and they've recommended it to their younger brother or sister, so we're now working on second and third children from the same families. For the lots of kids who really do not function in traditional math, IMP is another vehicle for them, where they can not only learn math, but also be as creative as they choose to be. This is appealing to parents.

Parents have a whole lot of legitimate concerns. Parents' nights are absolutely essential, because kids are going home with homework that parents look at and say, "What is going on here? What is this?" Some parents have trouble seeing the math when they flip through the materials, so they ask, "Is my son or daughter going to get enough math to take the SATs? Will they be prepared for college? Will colleges accept this as a legitimate math course?" So as well as having the school schedule parents' nights for all teachers and all disciplines, we also have scheduled IMP parents' nights that are more of a learning experience. Every year we have one or two IMP parents' nights, where the parents come in and we have a little coffee and talk about IMP. Then the kids run a workshop for the parents, where the parents become the students and the kids become the teachers. Those have been so successful. Parents are our best public relations. ■

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JIM COOK ▸ PRINCIPAL

Why IMP?

Five years ago, my math department came to me and asked that we sit down and talk about the *Interactive Mathematics Program*. They and the math coordinator from downtown were talking about it. They were excited about it, so we were the first school in this district to start it, with IMP 1. Now it is offered at the three 9–12 schools in the district—Longmont High, Niwot High, and us.

Skyline uses IMP in grades 9 through 12. It's one of two different ways to get your math education—we did not go entirely IMP. We kept the traditional math track, and that really has been key, because we don't have to argue, and we don't have to continue to sell. Each year one of our math teachers will take some of our *Interactive* kids and go talk to 8th graders, and send stuff home. Probably next year we'll have about 60% of students taking IMP. Over the years, we've decreased the number of straight Algebra or straight Geometry classes we have, but we still have them.

When we started IMP, we figured we had a couple of issues. Statistics about IMP then were not as great as they are now, but they were saying that kids' ACT and SAT scores were either equal to or greater than scores of kids in the traditional math programs. So we figured that we probably weren't going to do any harm. I knew nothing about it, but my math people thought that it was dynamite. I met with Jean Klanica, the regional IMP director, and some others. I even went to a couple of workshops where I was really outclassed, because they were talking math. But I did learn a lot about what was going on. There was just some risk in stepping out and doing it, and not knowing. I mean, we get to this level, and every parent thinks anything we do differently may affect college entrance, or scholarships. And we just didn't want to mess with that.

Textbooks in this district are adopted district-wide, and they've been on about a seven-year cycle. And that's the process we've always used. With *Interactive*, we also had support from our math coordinator, who was like a teacher on special assignment at that time. She helped us here, both financially and in getting all the text materials and everything for IMP. So we had support from our central office to do this.

Strengths of IMP

I think a strength of IMP is certainly the problem-solving. Kids will have a better memory of how to approach a math problem and figure out a way to get an answer, and not have to rely on remembering some equation that was written on the board. I also think the interaction of the kids in class is excellent. When they present, it's pretty impressive to hear kids who probably are frightened to have to do a speech in English class, yet who will get up and use an overhead and other tools, and demonstrate to a class of their peers how they came up with their answer.

At the end of the first year of IMP, I think that a traditional Algebra student probably knows more algebra than the IMP kid does. But the IMP kid knows some other things mixed in that that algebra student hasn't even been exposed to yet. And I think probably after the second year, a student who has taken traditional geometry probably knows more geometry than the IMP kid. But again, the IMP student's getting the more global view of the whole thing, and demonstrated knowledge that they can solve the problem. That's what we've got to think about when we're talking about what we call in our district the "standards proficiencies."

At the time of this interview, Jim Cook was in his ninth year as principal of Skyline High School in Longmont, Colorado. He has spent time as an administrator at the elementary- and middle-school levels, as well. Jim has also been a teacher of instrumental music at the middle- and high-school levels.

Skyline High School is located in the St. Vrain School District, which serves approximately 17,000 students in suburban and rural parts of central Colorado. At the secondary level, the district contains three 9–12 high schools, three 7–12 schools, an alternative high school, and a career development center. Within the district, as many as 25% of students are of Hispanic origin; about half of those are ESL students from families that have recently immigrated.

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The teacher is able to observe students solving the problems—demonstrating that they are solving them—during oodles of class minutes, in addition to on tests and homework and other kinds of assessments. But I think we're holding the kids more accountable for really learning what we hope they've learned, what we're trying to teach them. And they do demonstrate it. There are not many places to hide.

I've been called to the classroom on several occasions just to see somebody present something, or I drop in and just watch a group of kids make a presentation about a problem, or watch them work on something. Some students find it frustrating. They think, for a while, and we tell them up front, "You may think you're not learning. It's truly entirely different than the way you learned math in the past eight years. So don't panic. Don't overreact. Actually, everything's working fine." We'll have two or three parents a year that want to put their kid back in the traditional track—it's not a huge number.

Another strength is how we see IMP skills carry over into other parts of school, other disciplines. When they present things in other classes, students are more confident, which is not necessarily a math issue, but it's certainly a big issue. Teachers are pleased by the way they go about coming up with a reasonable answer in other classes, whether it's science or social studies; they're just using better reasoning.

Preparing the community

There are some real important things that you do up front if you're thinking about switching to IMP. We were very careful when we started. I think some of the smaller schools in the district would like to have IMP, but don't think they can keep both tracks going—they have to convert either all to IMP or stay all with the traditional. I think that's probably the reason some of our smaller 7–12 schools, which may only have 350 high-school kids, are not doing it—because it's too hard to staff.

We also give people the option of switching. We don't give them that option for very long, but we do talk about it. And some kids, quite frankly, are very frustrated with the IMP process. They want to be told how to do it, and they want to do 50 more questions like it, and work the problem. That should change as our middle schools start using some of these concepts.

We spend a lot of time feeding information to parents. We did that most in the first and second years, but we still have those informational handouts. We hold a meeting, usually pretty early in the fall, for parents and their kids to come in at night, sit down, and work a problem, to let the parents see how it's done. The parents actually are involved in it. And I've found that the POWs—Problems of the Week—have become dinner table conversations. I mean, these are pretty tough problems, and families are working together to solve them. So I think that up-front stuff is real important with parents.

We did not want anybody to ever think that *Interactive Math* was an alternative math program for the less qualified. So we were very careful in all of our conversations and literature about that, that choosing this program has nothing to do with if you're weak in math or if you're strong in math.

Challenges for students

What's challenging for students is their adjustment as 9th graders when they come into IMP 1, because they're not used to this way of not getting things fed to them so easily. It's a challenge for them to work in groups; often they've had bad experiences in middle school with that.

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I also know those Problems of the Week are tough. They're very much like riddles and puzzles and math all wrapped up in one; they're very complex. So I think the kids have to think more, and that's not too much fun. That's the reason we're addressing reading at this school, because we found that our population of kids—and I think kids everywhere—aren't doing very well with comprehension. The POWs are not all laid out for you. You have to make some decisions.

Engaging teachers

One issue that has come to me is the traditional teacher who has been teaching maybe 8–10 years, who says, "I don't want to be involved in that. It looks too wishy-washy. I don't like group work. I don't know how to deal with that." So, dealing with a teacher like that, we've got a couple of choices. We might try, "Okay, then keep your mouth shut and don't bad-mouth it to other students." Or we encourage them. "Why don't you go and spend a week and see what it's really like, and then we'll talk." So everybody in our math department over the last four or five years has either been supportive enough not to bad-mouth it, or has been supportive of it to the degree that they wanted to be involved. We had no problem getting people involved at first, and really have no problem now.

You've got to work with teachers in understanding that group work is okay if it's structured right. Just putting students in groups and saying, "Go do this" is not the way to do it. You need to have some instruction on how best to divide your class and make sure that kids are doing something when they're in that group. I think high school teachers look down on that as an elementary process, something we don't do in high school. But I think that's a real positive thing about *Interactive Math*—the interaction of the kids working together. We hear all the time from businesses that the kids the public schools are putting out don't know how to work in teams. Well, they know how to work in teams around here, when they're in *Interactive*.

So staff skills have to change. Teachers have to adjust to students working on projects or problems that are pretty complicated and lengthy—they may last three or four weeks. Their math doesn't change, but their procedures and their methodology for getting it across to the kids has to change. I think teachers in general love to impart information and let the kids know how knowledgeable they are. Well, when you're teaching this, you don't come across quite that way. You just don't give them all these beautiful answers right at the beginning. Holding back from that is a skill that has to be developed.

I don't think we've had any more classroom management problems with IMP than we have with other classes. It all depends on the person in charge up there in that room, and if they have the skills to get 25 kids on task, it doesn't matter. I come from a school that doesn't think that kids have to be lined up and quiet in order to be learning. So I see in lots of our rooms, that there's quite heated and varied discussions, and different kinds of things going on. But I don't automatically jump to the conclusion that things are out of control because kids are talking.

Teacher support

The IMP strategy is a very thoughtful way of introducing or piloting a course, because there is so much support for the teacher and for the school to start working this way. Everybody who has ever taught it here has gone to a summer institute on it. There's release time throughout the year. Teachers get an extra planning period when they first teach it, to meet with other people teaching it in the building. The whole staff development issue was very well handled. There was plenty

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of time for teachers to learn how to teach differently. The math didn't change, but the way of teaching certainly is different. Jean Klanica was very helpful the first couple of years we did it. She would meet with us when we met with parents at the beginning of a year, and so forth. It would be nice if everything we did could be introduced this way. The IMP implementation center's grant put a lot of money behind it and allowed us to offer these people this extra time.

The release time from teaching during the day, in order to meet with peers to talk, or to meet once or twice a week with a supervisor-type, was excellent. That's the trick to it, because the teachers had plenty of time to really think about what they were doing, and work on it, and get advice, and observe each other, and talk about how they do it. We have a lot of teachers in our math department who don't only teach *Interactive Math*—they may have a class or two of traditional also. We're finding that they're using more of the techniques of teaching IMP in their traditional math classes, which is sort of cool. Having staff development—not just a once a month, go-to-a-little-flimsy-hour-thing, but instead, during the school day, for which they had release time—was just super.

We haven't really talked about how we'll fund this extra teacher support after the IMP grant. There may continue to be the seminars in the summer and we just may have to pay for them. We just may have to budget money for staff development that way. I get several thousand dollars from the district for staff development, and I'll just have to earmark some of it for these people to have some release time, or to bring in a half-day substitute once every two weeks or so. During the grant, that extra planning period meant they just never taught a class during that period, so you didn't jeopardize them by pulling them out of one class to meet. And hopefully in this building, we can keep the quality people who are already trained, after this year and beyond.

One of my math teachers has become a guru with IMP—she knows it backwards and forwards. She was our math department chair at the time we started implementing, and now has become so proficient at this that she goes several times a week to Longmont High to supervise them and help them. They're a year or two behind us in the implementation.

Administrative issues

About the same time we started *Interactive*, we switched to this trimester schedule with 12 weeks of five 70-minute periods a day. So we keep IMP sequential; we have two halves to each year. So we try to keep it either first and second tri, or second and third tri. But because of the amount of stuff in the third year, and because we usually have one unit left over from the second year, we've had to schedule the third year of IMP to go all year long, three trimesters. So now, when a kid gets out of this school, if they've done all four years of IMP, they'll have four and a half credits in math, rather than four; and two are all that's required. So they're really getting a lot of math if they stay with the program.

We've found that it's really important to make sure that your feeder schools understand what IMP is about. We had a little bit of a problem those first couple of years with a math teacher at one of our feeder middle schools. He was bad-mouthing the program, saying that it was for the low end. So we had to straighten that out. Now, because they're moving to *Connected Math* in the middle school, hopefully that won't happen. But you just never know who's going to torpedo you, and usually it's somebody inside. That's why it's important to work with the staff at the beginning.

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We have a math department of eight people. We hired a couple, maybe three new teachers this past year. Both then and as we're interviewing now, we try to find people either with IMP experience or who are willing to learn the program. This is coming up to be the last year, I think, that we will get support from IMP to train people. So we've got to have the training built in, that our district can do. So we've now set up things for this next year, for people that we're hiring, that they either have to have IMP experience, or we have to get them trained.

We also had some budgetary issues at first, in buying the graphing calculators. But we got grant money for some of that. We can be pretty resourceful. We also just beefed up the math budget for a couple years. Any time a course is taught for the first time, people are flying everywhere, trying to get everything, and get things copied and stuff. But after the first time, everything sort of gets there and then we don't have that problem.

Technology

We have what we call a Power Lab up in the math department, and the IMP 1 or IMP 2 classes spend time in there working on a lot of geometric stuff. We also have many sets of graphing calculators. All of our classes now, even the traditional, use graphing calculators a lot. It's been a huge adjustment for teachers to learn how to use them. I think kids are also challenged by the use of the graphing calculators. But boy, I was in a class three weeks ago, where they were using graphing calculators, and I was amazed at how well they were doing. These were freshmen in IMP 1. They've learned some new skills. And a lot of them now own their own; we're finding that graphing calculators are popular Christmas presents.

Student achievement and testing

Our ACT scores with the IMP kids are as good or better than our traditional kids. We've been very pleased. In fact, we've started a program here with our local community college, where our juniors will take classes taught by our staff, but they will be the community college curriculum. If they stay in the program, they'll have their core subjects in their first year of college done when they graduate from high school. When kids took the math part of their entrance test for the community college, there was a little bit of surprise at how many of these sophomores, who at that point had not even finished two years of high school math, knew some questions that they really shouldn't have known the answers to. Well, they were IMP kids. They were getting a little bit of probability, and a little bit of trig, and a little bit of those things that they wouldn't have normally had by then, all mixed in.

Serving different students' needs

Next fall, we would like to offer an ESL IMP 1. Now, that may be a real challenge. But I just hired a teacher who is a fluent Spanish speaker, who's going to teach Spanish to Anglos, and she's going to teach math. She'll be going to the summer institute for IMP. Language seems to be less of an issue in a traditional math class; I think a lot of it is the amount of reading, perhaps. But in IMP, it's going to be a challenge.

IMP has certainly stretched kids to take more math than I think some of them would have taken before. They would have taken the two years. But next year we have two AP Calculus classes of seniors, which is the first time we've had to have two, plus we have two IMP 4s. So to me, that means we've got three more sections of seniors—that's 75 more kids—taking math in their senior year than before. ■

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