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Teacher-Educator, Interactive Mathematics Program

Sherry Fraser,
Teacher-Educator, Interactive Mathematics Program

Publisher
Steven Rasmussen

National Sales Director
Kelvin Taylor

Consultant
Mary Jo Cittadino

Key Curriculum Press
1150 65th Street
Emeryville, California 94608
510-595-7000
1-800-338-7638
Fax: 1-800-541-2442
sales@keypress.com
http://www.keypress.com

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Preface

We at Key Curriculum Press have been serving educators since 1971 and we remain steadfast in our commitment to support high-quality mathematics education by providing innovative textbooks, software, supplemental materials, and professional development. Key Curriculum Press is proud to be publishing the critically acclaimed curriculum materials developed by the Interactive Mathematics Program®. This curriculum is in keeping with our traditions of innovation and excellence.

The Interactive Mathematics Program developed its high school curriculum to transform into reality the vision of the National Council of Teachers of Mathematics (NCTM), as embodied in their *Curriculum and Evaluation Standards for School Mathematics* (1989). The IMP™ curriculum is now a proven and successful alternative to the traditional curriculum, in keeping with the *Principles and Standards for School Mathematics* (NCTM, 2000). This four-year core curriculum of problem-based mathematics replaces the traditional Algebra I–Geometry–Algebra II/Trigonometry–Precalculus sequence. It integrates traditional areas of mathematics with new topics such as probability, statistics, discrete mathematics, and matrix algebra in exciting and innovative ways.

It is only natural that questions would arise about a mathematics curriculum that is so different from the one currently being used in most high schools; we address many of these questions in this document.

In creating this document, Key Curriculum Press turned to the Interactive Mathematics Program—a community of teachers, teacher-educators, and mathematicians. This community has learned a great deal about change since beginning in 1989. They not only responded to our initial set of questions but contributed others of their own. As a result, this introduction to the Interactive Mathematics Program is based on the experience of the program’s directors and writers as well as that of the hundreds of teachers and many thousands of students who have been implementing the Interactive Mathematics Program daily in their schools.

Steve Rasmussen
I. The Need for Change

Several factors—the growth of technology, the increased number of applications, the impact of computers, and the expansion of mathematics itself—have combined in the past quarter century to extend greatly both the scope and the application of the mathematical sciences. Together, these forces have created a revolution in the nature and role of mathematics—a revolution that must be reflected in the schools if our students are to be well prepared for tomorrow’s world. Education reflecting only the mathematics of the distant past is no longer adequate for present needs.¹

Broad consensus exists among leaders in professional organizations, business, industry, and education that students need to become better prepared for the world they will inherit. Students need a higher level of mathematical, scientific, and technical literacy than they have ever needed in the past. As they enter the professions and trades and assume their roles as decision-making adults in a democratic society, demands are being placed on them that require problem-solving, communication, and reasoning skills that are not being provided in the typical high school program.

I. The Need for Change

In today’s diverse world, with its many challenges, society cannot afford to have only an elite few who are mathematically literate. The ability to read and think mathematically is basic for functioning effectively and such literacy is continuing to increase in importance.

In fact, mathematics education is not even meeting the needs of the twentieth century, let alone those of the twenty-first. The high school curriculum has changed very little in the last century, despite the fact that society and its technological tools have changed. The voices of dissatisfaction come from different directions:

- Students are “voting with their feet” against the mathematics education they have been receiving. Most take only the minimum required mathematics program, dropping out of mathematics as soon as possible.

- Classroom teachers are dissatisfied with the kind of mathematics education their students have been experiencing, convinced that it is not serving their students well, even the best students.

- Professors complain that students admitted to their colleges and universities are unable to think and reason mathematically, even though many of these students graduated from high school with top grades in advanced mathematics classes.

- Leaders of business and industry lament the fact that they need to retrain so many of their employees because they lack basic mathematical problem-solving and communication skills.

The Interactive Mathematics Program is one response to a critical need for change in mathematics education.

Changing the curriculum requires hard work. Teachers at an inservice for Year 3 prepare their group presentation.
II. What Is the Interactive Mathematics Program?

The Interactive Mathematics Program (IMP) is a growing collaboration of mathematicians, teacher-educators, and teachers who have been working together since 1989. This group has created both an exciting full four-year secondary mathematics curriculum and a rich professional development program for secondary mathematics teachers. This new curriculum meets college entrance requirements and prepares students to use problem-solving skills in further education and on the job.

IMP's work has been guided by the *Curriculum and Evaluation Standards for School Mathematics*, from the National Council of Teachers of Mathematics (NCTM). This visionary document calls for a core curriculum for all secondary school students and for changes in the way mathematics is taught.
II. What Is the Interactive Mathematics Program?

How the IMP Curriculum Is Different

The IMP curriculum looks and feels dramatically different from the programs that have existed in most schools for many years.

- It is problem-centered.
- It is integrated.
- It expands the content scope of high school mathematics.
- It focuses on developing understanding.
- It includes long-term, open-ended investigations.
- It can serve students of varied mathematical backgrounds in heterogeneous classrooms.

The IMP curriculum is problem-centered.

Units of the IMP curriculum generally begin with a central problem or theme. Students explore and solve that problem over the course of the unit.

*How long does it take for a 30-foot pendulum to complete twelve periods? How can you predict the length of a shadow? What is the best design for a honeycomb? What is the probability that the baseball team currently in the lead will win the championship, given the current record of its closest rival? What’s the best way to resolve the conflicts of a particular land-use situation within the constraints of competing political and social forces? When should a diver be released from a rotating Ferris wheel in order to land safely in a moving tub of water?*

*Principal Robert Emberton of Shasta High School makes a special appearance as a bob for the final pendulum experiment.*
II. What Is the Interactive Mathematics Program?

These are a sampling of IMP’s central unit problems. Some are based in real-world situations; others, in more fanciful notions. These problems are generally too complex for students to solve initially. As teachers guide them through a variety of smaller problems, students develop the mathematical ideas and techniques they need in order to solve the central problem. It is common for challenges in later units to build on earlier units, requiring students to apply what they have previously learned in ever more sophisticated and complex ways.

Because the IMP curriculum is problem-based, students get a rich experience of the way mathematics is actually used. Teachers relate how gratifying it is that they never hear IMP students ask, “When are we ever going to use this?”

Appendix A: A Unit-by-Unit Summary of the IMP Curriculum provides a brief description of each unit and shows the organization of the curriculum units by year.

The IMP curriculum is integrated.

Solving a particular unit problem often requires concepts from several branches of mathematics. IMP’s problem-based approach helps students to see how important ideas are related to each other. Mathematical concepts are integrated throughout all four years of the curriculum, instead of being isolated from one another. Therefore, it is inaccurate to label any of the IMP courses with such familiar titles as Algebra, Geometry, or Trigonometry. The integrated character of the IMP curriculum also includes the use of other subject areas—such as history, physics, and literature—as settings for the mathematical content.

Appendix B: Concepts and Skills for the IMP Curriculum gives a year-by-year outline of mathematical topics in the IMP curriculum, including both the new and the traditional content. Appendix B also contains a chart correlating the IMP curriculum with NCTM’s 2000 Principles and Standards for School Mathematics.

The IMP curriculum expands the content scope of high school mathematics.

The IMP curriculum follows the recommendations of NCTM’s Standards to include new topics in the high school curriculum, such as probability, statistical reasoning, and discrete mathematics. These topics are essential in the mathematics education of students, and reflect the demands of present-day society on its citizens and its workforce. The curriculum also makes...
II. What Is the Interactive Mathematics Program?

The IMP curriculum focuses on developing understanding.

The IMP curriculum is designed to help students develop an in-depth understanding of mathematical concepts and techniques and of the ways to apply them. The curriculum challenges students to explore open-ended situations actively, in a way that resembles the inquiry method used by mathematicians and scientists in their work. Students routinely experiment with examples, look for and articulate patterns, make, test and prove conjectures, and make connections among mathematical ideas.

The IMP Year 1 unit *The Pit and the Pendulum* provides a concrete example of what this can mean. In this unit, students are presented with the problem of whether the prisoner in Edgar Allan Poe’s classic story would have enough time to escape the blade on a 30-foot pendulum that will reach him in only 12 more swings. To resolve this question, students construct pendulums and conduct experiments to find out what variables determine the length of a pendulum and what the relationship is between the period and these variables.

Students are introduced through experiments and examples to the related concepts of the normal distribution and the standard deviation. Though college students usually learn about these statistics concepts as formulas to be memorized, for IMP students these concepts are tools to help them determine whether a change in a given variable really does affect a pendulum’s period. Thus, they have a compelling reason to really understand the concepts, because they are using them in the context of a meaningful problem.

Once they discover what determines the period, they analyze data and use graphing calculators to find a function that fits their data closely. Finally, after deriving a theoretical answer to the problem, students build a 30-foot pendulum to test their theory. The first time teachers use this unit, they are amazed at the accuracy of their students’ predictions.

The IMP curriculum can serve students of varied mathematical backgrounds in heterogeneous classrooms.

A curriculum built around complex, open-ended problems can be explored at many levels of sophistication. The central problems in IMP units have a

---

**Nikki, IMP student**

*The main difference I see between IMP and the traditional algebra track—algebra has many equations to memorize while IMP has few. I’m not concerned about this because the algebra students won’t remember anything anyway. The public's perception of mathematics needs to be transformed to the more positive perception of mathematics as something they are capable of doing. . . . it is exciting, beautiful, and fun.*

**Dave Robathan, Shasta High School, Redding, CA**

*The first time I had an IMP 1 class build a 30-foot pendulum to check our mathematical prediction for 12 periods was incredible. The city brought a fire truck and all the IMP 1 classes gathered to watch the swinging of the 30-foot pendulum. . . . The timing matched our mathematical prediction exactly. I was able to join the students in a tremendous sense of accomplishment, excitement, and satisfaction.*
II. What Is the Interactive Mathematics Program?

richness that will challenge the brightest student and a concreteness that allows all students to do meaningful mathematical work.

The curriculum also includes a varied collection of supplemental problems for each unit. These supplemental problems give teachers the flexibility to meet individual student needs. Extensions can be used for students who quickly understand a concept and want more challenge. These activities require students to take ideas from the IMP curriculum farther than the basic unit does. Reinforcements can help students who need additional experience in order to better understand and synthesize what they have encountered in the unit.

Because each unit of the IMP curriculum allows for many points of entry and many levels of achievement, this curriculum is ideal for schools that want to create heterogeneous classrooms.

The IMP curriculum includes long-term, open-ended investigations.

Each unit contains several Problems of the Week (POWs). These are open-ended problems, often mathematical classics, that cannot be solved easily in a short period of time. Though POWs are embedded within the units, the mathematics of these problems is usually independent of the unit problem.

POWs help students develop thoughtfulness and perseverance, and force them to focus on their own thinking processes. Students must explain and illustrate their strategies and solutions, and must justify their reasoning in clearly written reports. Over the course of the school year, each student will make at least one oral presentation to the class on a POW.
II. What Is the Interactive Mathematics Program?

How the IMP Classroom Is Different

IMP’s rich curriculum and its focus on understanding require changes in the classroom. The discussion below looks at several aspects of this change:

• An expanded role for the teacher
• A more active role for the student
• Extensive oral and written communication by students
• Both teamwork and independence for students
• Assessment using a variety of criteria
• Use of graphing calculator technology

The IMP curriculum requires an expanded role for the teacher.

Because the curriculum goes beyond mechanical skills, the teacher’s role must expand as well. Not simply an imparter of facts, the teacher must also be a keen observer, a sympathetic listener, and a skilled facilitator to ensure that students progress in their learning. The teacher asks challenging questions and provokes students to do their own thinking, to make generalizations, to discern connections and relationships, and to go beyond the immediate problem by asking themselves “What if?” The teacher uses his or her expertise to provide the “glue” needed to help students tie ideas together and to clarify any misconceptions that may arise.

One facet of the teacher’s role that does not change is the maintenance of a positive learning environment that conveys confidence in students’ capabilities. Teachers continue to set high standards and have high expectations for every student.

The IMP curriculum requires a more active role for the student.

Just as the role of teachers changes, so does the role of students. In many traditional classrooms, a student’s task is to mimic the work presented by the teacher and to find numerical answers to similar problems. But in a world that is ever changing, students need to be equipped to handle problems they have never seen before, and to handle them with confidence and perseverance.

To meet this need, the IMP curriculum is designed to give students a more active part in their learning. They work with complex and realistic situations, rather than with problems fitting a rigid format. They construct new ideas by moving from specific examples to general

---

Jordan, IMP student
I liked IMP. I’m doing very well in my college. I’m training to be a commercial pilot and I have to know what to do in an unexpected situation. IMP taught me to break down a problem and develop a creative solution. I seem to learn more easily than the other students.
II. What Is the Interactive Mathematics Program?

They progress beyond simply finding numerical answers; they use those answers to make decisions about real-life problem situations. They generate probing questions for each other and challenge each other's ideas. They must justify their reasoning by explaining to the teacher and to their peers what approaches they tried, what worked, and what didn’t.

The IMP curriculum involves extensive oral and written communication.

Many students think of math class as the one place where they don’t have to write a complete sentence or say anything more complex than a single answer. The IMP classroom is a radical departure from this image.

Through POWs, daily homework, and in-class activities, IMP students are constantly communicating in writing about mathematics. Many assignments ask them to synthesize ideas, which may mean summarizing a week or more of concept development in their own words. Students are sometimes asked to write reports as if they were professional consultants hired to give advice about a problem. During class, students are talking with each other about mathematics and making oral presentations about challenging problems.

By communicating their ideas to others, both orally and in writing, students reach deeper levels of understanding. Questions from classmates require student presenters to refine and clarify their thinking. Such opportunities to explain, defend, and convince others of their ideas help IMP students to develop and hone communication skills that will be important to them in school and on the job.

In the IMP classroom, students learn both teamwork and independence.

IMP students spend much of their in-class time working together in teams; the curriculum promotes this type of interactive learning through its use of complex problems. In or out of class, they are encouraged to talk and do mathematics with other students, with teachers, and with parents. They learn to share ideas, build on each other’s efforts, communicate, and take risks.

At the same time as students are expanding their ability to work productively with each other,
II. What Is the Interactive Mathematics Program?

Dr. Sally Mayberry, Assistant Professor, Mathematics Education, St. Thomas University, Miami, FL (after observing an IMP class)
Groups were comfortable with each other and willing to take risks with one another. Presentations were clear and precise. Students were eager to present. Wow!

In IMP, teachers assess student learning according to a variety of criteria.
Assessment in the IMP classroom is an ongoing, daily process. Neither timed tests nor multiple-choice or short-answer questions are adequate for assessing what teachers value most—real understanding of and ability to use mathematical concepts. Assessment in IMP is varied and is designed to help students understand what is important in mathematics.

Therefore, assessment of individual students in IMP is done 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, student self-assessments, and student portfolios.

Jean Klanica, IMP teacher, Eaglecrest High School, Aurora, CO
We were working with the part of the cube unit where the kids are developing the cosine or sine of the sum of two angles. The student at the board got to a point where she was stuck. She turned around and said that it just wasn’t making any sense to her any more. The whole class became totally focused on her dilemma. They totally took over—asking questions, answering questions, not interrupting each other. It was so hard just to sit there and do nothing. I wish we had videotaped that class. When I think of a perfect IMP class, that is the day that comes to mind.

The IMP curriculum incorporates the new technology of graphing calculators.
The IMP curriculum incorporates graphing calculators as an integral part of the development of mathematical ideas. These calculators are always available to students, and the students decide when to use them. They come to regard the calculator as simply another tool to use, like paper and pencil, in working on problems.

This technology enables students to see mathematics and problem-solving in a different way. They can focus on ideas and not get bogged down by tedious computation; they can do experiments, trying hundreds of examples; they can formulate conjectures and test them quickly; and they can solve problems based on real-world situations. They use the technology to create simulations, develop mathematical models, and create graphics.

IMP’s Record of Success

It stands to reason that before teachers or districts would undertake the kind of changes described in the previous section, they would want some assurance that the program is successful. The record provides this assurance on many levels.
II. What Is the Interactive Mathematics Program?

The IMP curriculum has been thoroughly field-tested. This is probably the most carefully and thoroughly field-tested program you will ever see. Beginning in 1989, IMP began a testing and evaluation process that has involved hundreds of teachers and tens of thousands of students throughout the United States.

- Almost every activity was used at teacher workshops and evaluated by participants before ever being used in the classroom.
- Initial drafts of each unit were reviewed by subject-matter experts before field testing.
- Field testing involved schools with widely varying demographics.
- During field testing, the IMP directors sat in classrooms every week, talking with students, observing their reactions to the activities, and meeting with teachers to hear their insights.
- Two of the IMP directors team-taught the first three years of the program in its initial draft.
- Each unit was revised after its first field testing; the revised units were field-tested in hundreds of classrooms over a four-year period. A few units were revised again during this period.
- The entire program was classroom-tested in real time as a four-year sequence, so that each unit could build on what students had learned earlier in the program. Units were never tested in isolation.
- After this extensive field testing, and with the full curriculum written, every unit underwent a thorough reexamination with a team of experienced classroom teachers, based on the longitudinal experience of the extensive field test. This reexamination led to yet another revision.
- These revised versions were retested in several classrooms (an IMP director was one of the teachers testing this version); once again, the feedback of teachers was incorporated into the curriculum.

The IMP curriculum is mathematically sound. IMP directors Dan Fendel and Diane Resek, who are the authors of the curriculum, are professors of mathematics at San Francisco State University. They hold doctoral degrees in mathematics and have written mathematics research articles and college mathematics textbooks.

IMP's Advisory Board includes nationally recognized mathematicians and mathematics educators:

- David Blackwell, Professor of Mathematics and Statistics, University of California at Berkeley
- Andrew Gleason, Hollis Professor of Mathematics and Natural Philosophy, Department of Mathematics, Harvard University
II. What Is the Interactive Mathematics Program?

- Milton Gordon, President and Professor of Mathematics, California State University, Fullerton
- Shirley Hill, Professor of Education and Mathematics, University of Missouri, and President of the National Council of Teachers of Mathematics, 1978–1980

The IMP curriculum is pedagogically sound

IMP directors Lynne Alper and Sherry Fraser, who field-tested the program, are highly regarded mathematics educators with extensive experience in the classroom as secondary teachers. For many years, they developed and led workshops at the Lawrence Hall of Science of the University of California at Berkeley; they have been in the forefront of efforts to improve the teaching and learning of mathematics.

The IMP curriculum is based solidly on the experiences of hundreds of teachers in IMP classrooms, who provided extensive feedback throughout the formal developmental process described earlier, as well as through informal conversations, by telephone, at workshops, and through electronic mail. These teachers have reported to the authors what did or didn’t go well in each unit, identifying potential trouble spots and sharing the solutions they have found to classroom difficulties. Their ideas have been incorporated into the final published materials and their teaching hints have been used in creating a detailed Teacher Guide for each unit.
II. What Is the Interactive Mathematics Program?

Formal evaluations show documented success.

Numerous studies have documented the success of the Interactive Mathematics Program. These include a major evaluation funded by the National Science Foundation (NSF), as well as local studies conducted by individual districts. The NSF study is led by Dr. Norman Webb of the Wisconsin Center for Education Research (WCER) at the University of Wisconsin, Madison. Dr. Webb is in the forefront of evaluation of mathematics education programs, such as the Urban Mathematics Collaboratives and other successful NSF mathematics and science programs.

Here are a few highlights of IMP’s evaluation successes.

- A detailed WCER study of all 1993 graduates at IMP’s three pilot schools showed that IMP students took significantly more mathematics courses than their counterparts in traditional programs.

- The same study showed that IMP students had significantly higher overall grade point averages than students in traditional programs.

- Another component of the WCER evaluation examined both IMP and non-IMP students at a large urban high school who had scored in the upper 25th percentile (based on national norms) on the seventh-grade level Comprehensive Test of Basic Skills. On the average,
II. What Is the Interactive Mathematics Program?

IMP students in this study of “high achievers” finished high school with higher overall grade-point averages and got higher SAT mathematics scores than non-IMP students with equivalent seventh-grade scores.

- In every one of many local studies of scores on standardized tests, IMP students have done at least as well as students in traditional programs. Because IMP students learn not only the material in the traditional curriculum but also other mathematical topics not covered on these tests, this represents an important achievement.

- A study in Philadelphia showed a 17% increase in attendance among IMP students as compared to their counterparts in traditional programs.

- In a 1995 study of innovative programs in inner-city schools by the Consortium for Policy Research in Education, students in an IMP course showed the highest gains in mathematics achievement among all programs evaluated.

- A 1996 WCER study of achievement in statistics, problem solving, and quantitative reasoning showed IMP students far outperforming students using traditional programs. This study used instruments developed independently of IMP and involved students in grades 9, 10, and 11 at three schools. In a 1997 study using the grade 9 and 10 instruments at three other schools, IMP students again significantly outperformed students using traditional programs.

- A 1998-99 study at Lincoln High School in California showed that IMP students scored higher than their peers on the Stanford Test of Academic Skills (SAT-9).

IMP has developed a series of documents that provide more details on these and other program results. These documents are available at the IMP Resource Center on the Web (www.mathimp.org).

The IMP curriculum has been rated as “Exemplary” by the U.S. Department of Education.

In October 1999, the IMP curriculum was named by the U.S. Department of Education as an “Exemplary” mathematics program (the highest rating possible). Of 61 K-12 mathematics programs submitted, only five achieved the “Exemplary” rating. This designation was the outcome of a stringent Expert Panel review process involving criteria in four categories: Quality of Program, Usefulness to Others, Educational Significance, and Evidence of Effectiveness and Success. To be rated as exemplary, a program had to demonstrate that it satisfied each of the criteria, including “convincing evidence of effectiveness in multiple sites with multiple populations” using several indicators of student gains. Details about the Expert Panel review process and the criterion for selection are included in the Department of Education’s publication Exemplary and Promising Mathematics Programs which is on the Web at www.enc.org/ed/exemplary/ and can also be obtained at 1-877-433-7827.

IMP students are achieving success in college.

IMP students have been admitted to and are succeeding at a wide variety of colleges and universities, including some of the most selective schools in the nation.
II. What Is the Interactive Mathematics Program?

When the program began in California, the curriculum had to undergo careful scrutiny from mathematicians in the University of California system. It has been officially approved as meeting University of California admission requirements, and other universities have followed suit.

Many students have written about their IMP experience as part of their college applications; admissions officers have responded enthusiastically.

IMP graduates have also been writing to their teachers about their experiences after they leave high school. They talk about how well prepared they are for more advanced mathematics. They also talk about the differences they see between their attitudes toward learning and the approaches taken by students with traditional preparation. IMP students describe themselves as more inquisitive, more confident, and better able to apply what they know in new situations.

Appendix C: College Acceptance of IMP Students lists colleges and universities that have accepted IMP graduates for higher education.

Teachers endorse this curriculum.

Change is not easy; moving from a skill-based curriculum to a deep, problem-based curriculum is an enormous amount of work. The willingness of so many teachers to accept this challenge and all the extra work it entails is a stirring endorsement of the program.

What motivates a teacher to switch to IMP?

Teachers are unequivocal in stating that the enormous rewards make it worth the effort. They report that they are energized and rejuvenated by the effect of IMP on their students—amazed by what students can achieve, by their insightful and innovative thinking about mathematics. Many of those who have used the IMP curriculum have always been innovative in their teaching; they come to IMP because it supports them in what they have been trying to accomplish on their own. Others are simply frustrated by the inability of their existing programs to meet the needs of their students.
Many teachers say teaching IMP has resulted in a change in their perception about themselves. They have come to perceive themselves as mathematicians as well as mathematics educators. They cite two reasons.

First, they are learning mathematics they never studied before, such as complex concepts from statistics. Second, even some veteran teachers of 25 and 30 years exclaim that they really understand for the first time why some of the procedures they have taught over and over again work the way they do. This enthusiasm about mathematics is infectious, and their willingness to keep on learning affects their students positively.

Business and industry support this kind of change.

Business and industry have been strong advocates of the kind of change in mathematics education that IMP provides; leading private foundations are putting dollars behind their words of support. For example, The Noyce Foundation, the Intel Foundation, and the David and Lucile Packard Foundation are major funders of IMP. These organizations promote the dissemination of IMP's work because they regard the program as successfully preparing students to think, to reason, to communicate clearly with others, and to work effectively as members of a team.

Fredrick H. Shair, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA (in a letter to an IMP teacher)

When David Flores invited me to attend the El Monte School Board meeting last month, I had no idea how upbeat the experience would be. The presentations made by the students who are participating in your Interactive Math Program were superb. . . . Your students demonstrated that they are truly mastering advanced mathematical concepts. The ways in which your students interact and communicate give hope that systemic improvement in math education is actually possible. Through their weekly reports and oral presentations, they clearly developed excellent communication skills. I was so impressed with your efforts that I have taken the liberty to invite persons at NASA Headquarters and at JPL to possibly visit your class.

Janice Bussey, IMP teacher and administrator, West High School, Tracy, CA

I have learned so much from my IMP students that I am now a firm believer that we are all truly “lifelong learners.”

A Brief IMP History

**IMP’s beginnings and funding**

IMP began its work in 1989 with a grant from the California Postsecondary Education Commission. The purpose of this initial grant was to revamp the Algebra I–Geometry–Algebra II/Trigonometry sequence and develop a three-year core curriculum that would set “problem-solving, reasoning, and communication as major goals; include such areas as statistics, probability, and discrete mathematics; and make important use of technology.”

In 1992, IMP began receiving major funding from the National Science Foundation. NSF grants have supported completion of the curriculum development, including development of a fourth year for the curriculum, as well as evaluation and dissemination. Additional funding has come from many sources, including The San Francisco Foundation, the U.S. Department of Education, The Noyce Foundation, the David and Lucile Packard Foundation, and individual school districts.
II. What Is the Interactive Mathematics Program?

**Field-testing**
The first three years of the IMP curriculum were field-tested between 1989 and 1992 at Berkeley High School, in Berkeley, CA; Mission High School, in San Francisco, CA; and Tracy Joint Union High School, in Tracy, CA. Berkeley High has a highly diverse student population. Mission High is an inner-city high school whose students are primarily Latino and Asian. Tracy High is in a rural community.

The fourth year of the curriculum was field-tested during 1993–1994 at Berkeley High; Mission High; Eaglecrest High School, in Aurora, CO; and Silver Creek High School, in San Jose, CA. Eaglecrest High is a suburban school in an upper-middle-class community. Silver Creek High has a diverse population, including many Latino and Vietnamese students.

**Expansion**
Between IMP’s inception in 1989 and the beginning of publication in fall 1996, use of the IMP curriculum grew from three schools in California to nearly 150 schools in 12 states. Since IMP’s primary goal is to provide high-quality educational experiences for both students and teachers, new schools were added during this period only if they made a commitment to guidelines based on the lessons that were learned at each stage of expansion.

**The IMP Organization**

In 1992, with the award of a major implementation grant from NSF, IMP began developing an organizational structure to support dissemination of the program. This structure consists of a national office, including IMP’s

*Julie Goldstein and George Martinez analyze a problem during a Year 4 inservice.*
four directors; regional centers around the country, each of which has its own regional directors; and an ever-growing cadre of teacher-leaders who provide support as local coordinators throughout the country.

**The IMP national directors**

Dan Fendel earned his undergraduate degree in mathematics from Harvard University and his Ph.D. in mathematics from Yale University. Diane Resek earned her undergraduate degree in mathematics from Wellesley College and her Ph.D. in mathematical logic from the University of California at Berkeley. Fendel and Resek have taught and developed curricula for students of all ages—from kindergarten through graduate school—and have extensive experience in both preservice and inservice training of teachers.

Lynne Alper and Sherry Fraser also have degrees in mathematics and extensive classroom teaching experience. Collaborating closely with the authors, they brought to IMP their many years of practical experience in teaching secondary mathematics and in planning, organizing, and developing mathematics inservices for K–12 teachers. Both Alper and Fraser taught the first three years of the IMP curriculum at Berkeley High School and gave feedback throughout to the two authors. Fraser is also teaching all four years of the revised, prepublication version of the curriculum. Both also regularly provide support to teachers through visits to IMP classrooms.

Fraser’s and Alper’s longtime focus on increasing the participation of minority and female students in secondary mathematics continues to be important to this project’s goal of developing a curriculum and pedagogy that provide better access to higher-quality mathematics education for these previously underrepresented groups.

*Janice Bussey, IMP’s outreach coordinator, works with Kevin Drinkard and Teresa Dunlap to reflect on how they will put into practice what they have just experienced in the Year 3 workshop.*
II. What Is the Interactive Mathematics Program?

**IMP regional directors**

Since 1992, the dissemination of the IMP curriculum has built on a structure of regional centers, each led by a team of two to four regional directors. With the support of the national directors, regional directors provide guidance and expertise in the process of implementation. Support for the structure of regional centers has come from grants from NSF and private foundations, and from a variety of local sources.

The regional director teams have a variety of skills and experience. They may be university faculty, mathematics supervisors, teacher-educators, or master classroom teachers released part-time from their districts. Regional directors perform many functions.

- They teach the program in regular high school classrooms.
- They visit schools, providing on-site support and suggestions to teachers.
- They provide mathematical expertise to teachers who are dealing with unfamiliar mathematics content.
- They lead inservice workshops.
- They provide advice about communicating with the general public, especially parents, about the mathematics education goals of a school or district.
- They help schools and districts to develop plans for implementation and to obtain the funds needed to implement change.

Kristen Livingston, Katy Anderson, Emily White, and Megan Hall discuss strategies for “the Counters Game,” an activity in the Year 1 unit “The Game of Pig.”
II. What Is the Interactive Mathematics Program?

- They speak at mathematics education conferences and in other forums, articulating the reasons why change is needed and communicating the educational principles that underlie the IMP curriculum.

**IMP local coordinators**

The final level of IMP leadership is the local level, where local coordinators support and assist implementation at a single school or group of schools.

Local coordinators are experienced IMP teachers, so this level of leadership lies with classroom practitioners. This practice arises from IMP’s policy of promoting professional development opportunities for classroom teachers.

Local coordinators handle many tasks, including public relations and communication with feeder schools, and provide educational leadership to a school’s IMP teaching team. They actively encourage networking among IMP teachers within their school communities and across schools, districts, and states, through professional conferences, telephone contact, school visits, and electronic mail.

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Kathy Sanders, local coordinator, Central California Coast area

Receiving visitors and responding to phone calls is a critical part of my week. The district and the site administration refer calls regarding mathematics reform in our K–12 district to me, and I in turn invite the parents, community members or teacher to visit me in my classroom. After they observe and participate in an IMP class I can then spend my professional development period sharing support materials and answering any questions that they may have. . . .

I have semimonthly meetings with the principal and (separately) the counselors to review recent IMP news, inviting the principal, assistant principal, dean of students, and teachers from other curricular areas to visit an IMP classroom. . . .

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Local coordinator Sylvia Turner works with Dave Robathan during their common preparation period.
III. Implementing the Interactive Mathematics Program

Transforming the curriculum and pedagogy of the mathematics classroom is no small task. It requires philosophical and financial support from administrators, hard work from teachers, and the understanding and backing of parents. Schools that have implemented IMP report that the greatest success comes when the whole school community is informed about the need for change and about the way the mathematics curriculum will be transformed to meet that need. There must be a willingness on the part of the community to be reflective and open to change.

Over the years, in many schools and in diverse communities, the Interactive Mathematics Program has learned a great deal about ways to put these components together. The structure of regional centers provides a support system to assist districts in making change.
Preparing for Implementation

Many steps must be taken before a single student begins the program. Much of the preparatory work involves educating all concerned about the scope and meaning of the changes involved in implementing this program. One good first step for everyone is to visit a school nearby that has already implemented the IMP curriculum, sit with students in IMP classrooms, and see how the program works.

Based on the experience of the many schools that have already implemented the program, IMP strongly recommends the preparatory work described below for various groups.

**District administrators and school board members**

District administrators and school board members should be aware of the mathematics reform going on throughout the United States and should understand how IMP fits into that reform movement. They also need to recognize the commitment of resources required to transform the mathematics classrooms in their district. Beyond the purchase of textbooks and related materials, this transformation requires significant support for the professional development of teachers.

**Curriculum leaders and other leadership personnel**

Curriculum leaders should be knowledgeable about the mathematics education changes being called for and be able to articulate them as
representatives of the school community. They should be aware that IMP’s pedagogical approach is based on sound research into the ways children learn.

Leaders within each school must be committed to the philosophy of the program and understand how it fits into the school’s overall education efforts. In particular, student placement should be appropriate and should reflect the fact that IMP is a college preparatory program designed to replace the Algebra I–Geometry–Algebra II/Trigonometry–Precalculus sequence.

When the chair of the mathematics department and the person accustomed to teaching calculus are supportive of IMP, the message is conveyed, especially to parents, that this is a valid college preparatory mathematics curriculum. It is even better when these departmental leaders begin teaching IMP. Even though not everyone will begin at once, it is helpful if the entire mathematics department supports the program’s implementation.

Involvement of science teachers is also an important ingredient of success.

School counselors play a major role by informing students and parents about curricular changes, so it is essential that counselors at the high school and its feeder schools be knowledgeable about IMP and be able to communicate that IMP is a rigorous college preparatory mathematics program that is appropriate for college-bound students.

**Mathematics teachers**

A significant number of teachers in the mathematics department should be committed to the philosophy of the program and be willing to commit their
III. Implementing the Interactive Mathematics Program

personal efforts to bringing about change. The larger the network of IMP teachers who understand the IMP philosophy and support each other, the better the chance of success for the school.

One of the best ways for teachers to understand what IMP is all about is for them to visit a school where the program is already in place. National and regional meetings of NCTM provide other opportunities for teachers to learn about IMP and about the larger movement of mathematics reform.

Implementation goes most smoothly if mathematics teachers have already used many of the pedagogical strategies that IMP recommends. For instance, it is helpful if teachers have previous classroom experience in which their students are

- working collaboratively in groups
- working on long-term, open-ended problems
- using graphing calculators
- being assessed based on a variety of criteria
- writing about mathematics and the processes they are using
- making presentations to the class about their reasoning and ideas

Some teachers are just beginning to make these changes in their own classrooms and may not be ready to implement an entirely new curriculum. To meet the needs of these groups, the Interactive Mathematics Program has developed a transition unit, *Baker's Choice*, which can be taught in traditional mathematics classes. *Appendix D: Beginning the Change Process* describes steps that schools can begin taking immediately to prepare for implementing the full program.
Parents and students

The decision to implement the IMP curriculum should involve parents and students. Parent-teacher organization meetings and back-to-school nights provide excellent forums for starting the conversation about the need for change.

This discussion can build on the fact that the world is changing and that the mathematical expectations facing adults entering the twenty-first century will be different from what was required of their parents. It is important to stress that the new programs do not shortchange fundamentals, but rather go beyond rote learning to encourage a deep understanding of the meaning and uses of mathematics. Having parents reflect on their own, often negative, experiences with school mathematics can help them understand why change is required. An active experience using IMP materials can give them a vision of how positive and exciting a mathematics program can be.

In addition to the general community education that should precede change, school and district leaders must work specifically with eighth-grade students and their parents, familiarizing them with IMP so they can make informed choices about participation. This process should begin by early spring of the year before IMP teaching begins; it is one of the most important steps in the implementation process.

David Slowik, President, Philadelphia Chapter of the Pennsylvania Association for Gifted Education, and Carleen Slowik, Reading Specialist, Harrington Middle School, Mt. Laurel, NJ.

We are writing on behalf of the Philadelphia Chapter of PAGE, and as the parents of Jason Slowik, who attends Central High School. PAGE is an all-volunteer advocacy group established in 1951 for the purpose of advancing Gifted Education in our state. Your school deserves hearty congratulations on serving as the key East Coast pilot school for IMP. The program’s cross-curricular, problem-based approach to teaching offers students valuable opportunities to grow as creative problem-solving leaders that America so desperately needs.

III. Implementing the Interactive Mathematics Program
IMP schools report that it is especially important to involve parents who perceive that their students have been succeeding in the current system, since these parents are the ones most likely to resist change. Parents need to hear about the limitations of the traditional mathematics curriculum, especially its failure to teach students to reason and understand what they are doing with mathematics. If possible, bring in parents and students from schools where IMP has already been successful and have them talk about their experiences.

Once the program is functioning, it is important to provide opportunities for parents to see its success. Many schools offer family IMP nights, during which parents actually work on problems from the curriculum with their children.

The IMP curriculum is designed to work in heterogeneous classrooms, whose students have had varying levels of success in previous mathematics classes. Successful IMP Year 1 classes have included accelerated students who have completed the first year of algebra in eighth grade, ninth graders who would otherwise have been enrolled in the first year of algebra, and students who might otherwise have been excluded from the college preparatory sequence.
Here are some characteristics of the successful IMP Year 1 environment:

- The great majority of the students are those who would otherwise have been placed in Algebra I or Geometry.

- Students work during class primarily in randomly created groups of approximately four.

- Students have ready access to graphing calculators during class.

- Students come to school ready to work and are expected to do homework daily.

Many schools have successfully implemented an honors option within the structure of the heterogeneous classroom. In order to earn honors credit, students make a commitment to complete additional work beyond what is normally required. The extension problems described earlier are often used as a component of this additional work.

Support and Training for Teachers

The most important players in successful implementation of the IMP curriculum are the mathematics teachers, who are being asked to make major changes in what they teach and how they teach.

- They must learn and understand mathematical concepts that are new to the high school curriculum. These ideas, especially from statistics and discrete mathematics, may not have been part of teachers' own mathematics education, and most teachers will have little or no prior experience in teaching them.
• They must develop a broader perspective on traditional mathematical concepts. Because IMP asks more from students in terms of conceptual understanding, teachers must learn to be flexible as students grapple with ideas. They must develop a sense of when to lead and when to give students the freedom to explore on their own.

• They must become adept at new pedagogical strategies, such as having students work collaboratively in small groups.

• They must attain skill with the new technology of graphing calculators.

• They must develop new questioning techniques to bring out deeper understanding.

• They must incorporate new approaches to assessment, including portfolios and open-ended problems.

In sum, they must adapt to all the ways in which the IMP curriculum and the IMP classroom are different.

Appropriate support and training are crucial elements in teachers’ success as they work to create change. Even the most experienced and skilled teachers at IMP’s field-test schools said this support was imperative for them. Support and training for IMP teachers in making these changes takes several forms, including inservice workshops, shared professional development periods, team teaching, and visits to and from experienced IMP teachers.

**Inservice workshops**

IMP’s professional development program includes inservice workshops to help teachers understand both the content and the pedagogy embedded in the curriculum. These workshops begin the summer prior to initial implementation and should continue during the school year.

*During an IMP teacher inservice Steve Hansen demonstrates to Sylvia Turner another way to approach the problem.*
IMP inservice workshops are led by experienced IMP teachers. For a school or district that is just getting started, this means connecting with IMP’s professional development network. Often it is most convenient to send teachers to workshop sessions that have been set up for them by an existing IMP regional center.

IMP inservice workshops deal with the full gamut of issues that arise for teachers as they implement the new curriculum.

Through all four years of the program, the workshops examine mathematical content. As teachers study the individual units, they become mathematics students again, working through sample activities and solving problems. Many units contain mathematical ideas that are new to them, such as the chi-square distribution or matrix representation of geometric transformations.

Other units require them to see familiar mathematics in a new way or to reexamine the way in which concepts should be developed in the classroom. In every unit, teachers challenge themselves and each other as they solve difficult Problems of the Week.

When teachers assume the role of learner by being students again, they gain a better understanding of student perspectives. They learn to appreciate once again what it means to be risk takers, to venture into areas where they are not already knowledgeable or expert.

Themes of how to promote understanding are intimately linked with the learning of mathematical content. Teachers struggle with issues such as “What question can I ask that will bring out student insight?”, “How do I help my students make the transition from an intuitive foundation to a more formal understanding?”, and “How do I present this idea in several ways so each student finds a method that works for her or him?”

Workshops also focus on pedagogical strategies: “How do I get students to work productively in groups?”, “What can I do to improve my students’ mathematical writing?”, “How do I use graphing calculators to enhance student understanding of mathematical concepts?”, and perhaps the deepest issue of all, “How do I change the focus of the classroom from my teaching to my students’ learning?”

The issues that concern teachers most change gradually from year to year. IMP Year 1 teachers are often focused on classroom management and on issues of assessment and grading. In IMP Year 2, they may want to work on developing better questioning techniques. By Years 3 and 4, the pedagogical issues are very few and the challenge of the mathematics becomes a greater priority.
Whatever the focus, the reflection teachers do as part of workshops pays dividends beyond the classroom, because it helps them become better spokespersons to the larger community about the need for change.

Another integral part of all IMP workshops is the building of professional community among teachers. Teachers do mathematics together, discuss teaching strategies together, and confront a range of issues that they all must deal with.

For many teachers, IMP workshops provide an invaluable opportunity to talk about their feelings as teachers as they work to do their best for their students.

There is some flexibility in the scheduling of inservice workshops. In one scheduling model, teachers meet for a full week in the summer and then continue to meet every six weeks throughout the school year. These follow-up sessions might be after school or on Saturdays. Another model combines five days in the summer with a block of three full days in the winter.

Though it might be convenient to try to do the entire inservice work in the summer, teachers agree that inservice must be ongoing. Workshops are much more effective if teachers can learn some of the basic pedagogical strategies and the content of the first few units, then come back later in the school year to continue the work. They get much more out of the workshops when they can build on classroom experiences.

**Shared professional development periods with colleagues**

For too long, most teachers have worked in isolation from one other, each in his or her own classroom. IMP teachers have repeatedly affirmed the overwhelming importance of being given time regularly and frequently to talk with their colleagues about what is happening in their classrooms.

At an absolute minimum, teachers who are teaching a given year of the IMP curriculum for the first time should have a common preparation period.

In the model that has been most helpful, teachers receive an extra professional development period specifically for IMP, which means a reduced course load as they make the four-year transition from a skill-based curriculum to a challenging, conceptual, problem-based curriculum. In this model, everyone teaching the same year of the curriculum forms a teaching team with a common preparation period. If a school or district has made every effort to provide this extra preparation period but doesn’t have the funds for all IMP teachers, first priority should go to teachers teaching IMP Year 1 for the first time.
Some schools have used other models for providing time for teachers to share ideas and experiences, such as after-school or weekend meetings (for which teachers should be compensated), full-day planning opportunities during the school year, or other forms of released time.

When teachers teaching the same course have a common preparation period, they derive many benefits. They can

• share what happened with students in their respective classes
• clarify their understanding of the mathematics of the unit
• review units in greater detail than is possible in the IMP inservices and look for the “big picture”
• solve difficult mathematics problems together
• help each other formulate open-ended questions for students
• suggest management strategies
• work through issues about the pacing of the units
• construct rubrics for holistic assessment
• develop realistic expectations of students
• support each other while confronting the difficult issues and feelings that arise with meeting new challenges
Team teaching
Some schools have supported teacher professional growth by allowing two teachers to form a team to teach one section of the same IMP course together. Teachers in the team provide each other with daily professional development. Beliefs and practices are clearly seen because as each teacher works with a colleague, they are observing, acting, and interacting constantly. Because they are a team, they can benefit from each other’s observations and perspectives. Opportunities to observe the class and sit with students are also enhanced; this allows each teacher to see the mathematics and the curriculum from the students’ perspective.

Visits to and from experienced IMP teachers
Sites that have implemented the curriculum in the past have found it essential to establish a program of classroom visits between new and experienced IMP teachers.

A visit to a Year 3 or Year 4 class provides a Year 1 teacher with a vision of what students can do over time, and validates the emphasis on new approaches to both curriculum and pedagogy. Similarly, having an experienced IMP teacher come to one’s own classroom can be a source of valuable feedback. In either case, such exchanges give new IMP teachers a chance to ask questions of a colleague who has already been down the road. For schools that are just starting out, such reciprocal arrangements can often be made with a nearby school that is farther along in the implementation process.

IMP teachers recommend that the experienced teachers involved in these visits include people whose expertise goes beyond the individual classroom. For example, by linking up with a regional center, a district can tap into a broader range of experience. New teachers might visit classrooms taught by regional directors and get feedback about their own classrooms from people who have seen a wide variety of teaching styles.

Growth of IMP Within a School or District
The first year of IMP implementation is the biggest step, but ongoing success also requires the development of a plan for IMP growth within the school or district. Most schools have added two or more teachers each year, until most or all of the mathematics department is participating.
The experience of schools and teachers during IMP’s field-test years suggests the following guidelines:

- Begin gradually, phasing in the program one curriculum year at a time.
- Have each new group of teachers begin with the IMP Year 1 curriculum and continue through all four years of the program.
- Have teachers reteach a given year of the curriculum at least once at the same time as they move on to the next year.
- Work to develop IMP leadership within the mathematics department.

**Gradual implementation**

IMP recommends that schools implement the program gradually, phasing it in slowly, one curriculum year at a time, until all four years are offered. It is important to keep the traditional college preparatory sequence at first, so that parents, students, and teachers retain choices. Continue to do so until the traditional curriculum is no longer a viable option, thereby avoiding unnecessary conflict. Change cannot be imposed from the top down; it will not work to force IMP upon anyone—teachers or students.

Generally, it is best to start with at least two teachers who have made it clear that they want to teach using the IMP curriculum. This ensures that teachers have colleagues with whom to confer and collaborate and that several sections of IMP’s Year 1 can be offered the first year. These initial teachers will be called upon to support and encourage the next group. They should be teachers with the potential to lead inservice workshops for their district in the future.

**Following the curriculum through all four years**

For most mathematics teachers, the curriculum they have been teaching is the same as the one they learned—algebra in ninth grade, geometry in tenth, then more algebra, trigonometry, and perhaps precalculus. They know what to expect, and they know how the program develops from year to year.

The IMP curriculum, on the other hand, is new to everyone. Most teachers have little or no experience with a problem-based curriculum or with integrated content, so they don’t know what to expect at each grade level. IMP teachers report that they experienced great anxiety when IMP Year 1 went by and students had not learned some topic that teachers associated with ninth grade.

Teachers need to see that the basics are all there, even if those basics are presented in a different way and in a different sequence. They need to experience for themselves the way in which the IMP curriculum spirals and unfolds. For instance, it moves cautiously in its introduction of formal algebraic manipulations. In IMP Year 1, students are mainly building...
intuition about the meaning and use of variables. However, teachers report that they saw how this approach paid great dividends in IMP Year 2, when students easily learned how to solve systems of linear equations and really understood what they were doing. Since the overwhelming majority of IMP students complete at least three years of the program (and most complete four years), this long view of learning is worthwhile.

When teachers have the opportunity to see the curriculum as a whole, they get to see how the “big ideas” in mathematics are developed and enriched over the four years. They learn which ideas are key and what facets to emphasize within a given unit. Teachers using later years of the program understand the foundation of knowledge that students have already established, and their understanding allows them to help students build on this foundation.

Teachers also need to see the long-term effects of a new pedagogical approach. Many teachers report mixed results in the writing or group work of their Year 1 students. When they see these same students in Year 3, turning in polished mathematical essays or energetically exploring mathematical ideas together, they realize that the innovative teaching strategies have paid off.

Lastly, teachers report how personally exciting it is to watch students grow. They comment that teaching IMP has given them their first opportunity to really connect with students. Likewise, IMP students report that IMP teachers become important people to them.

IMP students Lindsay Crawford and Catherine Bartz use graphing calculators which enable them to tackle more diverse and challenging problems.
Reteaching years of IMP

Although IMP recommends that teachers move sequentially through the curriculum, they also urge that teachers reteach each year of the program at least once while they move on. For example, a teacher might teach two sections of Year 1 during their first year with the program, then teach two sections of Year 2 and one section of Year 1 the following year.

This practice has several benefits. For one thing, teachers appreciate the opportunity to synthesize what they learned the first time around. They commonly express excitement about reteaching the program, saying they now have a clearer understanding of the structure and purpose of each unit and have a better grasp of the way the curriculum is organized.

Many teachers also comment that they were concerned about learning new mathematics the first time around. When they reteach a year, they are more comfortable and relaxed about the mathematical content and are better able to formulate good questions.

Teachers reteaching a given year of the curriculum also serve as mentors for their colleagues who are working through the curriculum for the first time. It is very productive for a group of new teachers if at least one teacher who has been through the material can join the new group as they struggle with change.

Developing teacher leadership

In any process of change, there are those who take the lead and those who prefer to follow. Implementing this innovative curriculum is no exception; every district using IMP should encourage its strongest teachers to move into leadership of the effort.
Those who pioneer the program at a given school can provide guidance to others at their own school and at other schools in their district. They can take major roles in the support and training of other teachers and become leaders of inservice workshops. They can become spokespersons to the general community about the need and rationale for change. Many of the teachers who worked with IMP in the program’s early years have become valued leaders at the district, state, and national levels of mathematics education.

As teachers take on these new roles, they gain insight into their own teaching and into the mathematical ideas they are presenting. This work helps them continue to grow as classroom practitioners and their students reap the rewards of their ongoing professional growth.

District-Level Responsibilities

Most of the hard work of implementing change will be done by teachers and administrators at individual schools. But district personnel, such as superintendents and curriculum specialists, have an important role to play as well. First and foremost among their responsibilities is to ensure that teachers receive the essential training and support discussed earlier.

Based on comments from schools that have already implemented curricular change, here are some further steps a district should take to support successful implementation:

- Provide additional professional development opportunities for teachers, such as encouraging and enabling them to participate in local, state, and national mathematics conferences.
• Collaborate with individual schools to develop a district-wide plan for the growth of IMP.

• Promote family IMP nights for parents at each school at least once during each school year.

• Establish regular communication about IMP with feeder-school eighth-grade parents, counselors, and teachers.

• Build communication between mathematics departments and other departments, especially science.

Costs of Implementation

Any discussion about the implementation of change would be incomplete without considering the issue of cost. It is important to distinguish between the costs of implementing IMP and the costs associated with supporting systemic change.

Systemic change

A decision to implement a program such as IMP should be based on the recognition that both curriculum and pedagogy must change to meet the needs of students. The experience of the Interactive Mathematics Program since 1989 shows that systemic change requires giving teachers full support and training as they make the transition from a traditional, skill-based curriculum to a problem-based and concept-based curriculum, and as they learn both new mathematical content and new instructional strategies.

One component of this support is to give teachers time to share their experiences with each other on a daily basis—for example, by reducing the teaching load by one class period whenever a teacher teaches a curriculum year for the first time. This is a departure from the usual practice of expecting teachers to do the hard work of implementing change in addition to their regular duties and responsibilities.

In private business and industry, it is common practice for employers to pay for training and reeducation when employees are asked to make changes. IMP’s experiences around the country attest to the fact that, as in the business model, spending money to provide teachers with time to work together is a worthwhile expenditure and an important ingredient of successful systemic change.
Cost of materials

The cost of the IMP curriculum materials compares favorably with that of typical high school mathematics texts. In addition to the cost of textbooks, schools must make a long-term investment in technology by purchasing class sets of graphing calculators so that each student has one available to use at will in the classroom. Since the IMP curriculum is a hands-on, interactive program, some other manipulatives must also be made available.

Addressing the Concerns of Parents

Parents are naturally concerned about the implementation of any major change in the education of their children. With IMP, their concern is amplified by the recognition that mathematics is a vital element of their children’s future, and by the fact that it is so different from what they experienced as high school students.

In fact, some of the most enthusiastic supporters of IMP are parents in the mathematics, science, and engineering fields. They have said things like “I wish I had learned mathematics this way when I was in high school. This is just what we do in our jobs.”

IMP’s advice to schools has been to avoid making sweeping curriculum changes all at once and to maintain their traditional program while adding IMP. Allowing students and their parents choices lessens anxiety about change.

The key to winning support from parents is communication, both before the program begins and after it is under way. IMP teachers have found that periodic family IMP nights are an excellent forum for conveying information about the mathematics program to parents. Frequently, IMP students are the leaders and facilitators at these events, guiding parents through the mathematics of the curriculum.

The questions below are some of those that parents frequently ask. The answers come from IMP’s experience since 1989.

How will this affect my child’s chances of being accepted into the college of her/his choice?

As noted earlier, IMP students have been admitted to a wide variety of colleges and universities, including some of the most selective schools in the
nation. More and more colleges are recognizing the importance of a broad high school mathematics education that goes beyond mastery of skills. They want students who can think and understand the world around them. As college admissions departments receive applications from IMP students and learn about this program, they are recognizing the IMP curriculum as meeting college admissions standards.

Students themselves are seeing that what they did in traditional high school programs is often inadequate to meet the demands of higher education.

What about standardized tests such as the SAT?

In numerous studies throughout the country, IMP students have performed as well as or better than students in traditional programs on standardized tests, even though IMP students spend far less time on the algebra and geometry skills emphasized by these tests. With the time saved, IMP students learn topics such as statistics and matrix algebra that other students don’t see until they reach college.

How do I help my child with homework or Problems of the Week?

Even though the mathematics in many homework assignments or Problems of the Week may be unfamiliar to parents, they can still help their children. General questions like “What do you know about that?” and “Can you find any examples?” will often help students when they are stuck. Many parents report that they themselves become very much engaged in their children’s assignments and that dinner table conversation often involves the mathematics their children are studying.

Are IMP students able to take calculus in their senior year?

Some IMP students have successfully studied AP Calculus as seniors, just as some students do following three years of a traditional program that begins in the ninth grade. The IMP curriculum helps make this option available by embedding work with functions throughout the program and by introducing derivatives in Year 3. Some IMP students have successfully completed both IMP Year 4 and calculus as seniors.
Which is better for seniors—IMP Year 4 or precalculus?

Many teachers see IMP Year 4 as better preparation for college mathematics. With its focus on big problems, the fourth year of IMP is more varied than a precalculus course. IMP Year 4 includes topics such as circular functions, computer graphics, and statistical sampling, as well as a unit on families of functions and how they are used to solve problems.

Many colleges and universities are now offering a “reform” calculus class, in which the focus is on developing conceptual understanding and presenting problems in context. Most calculus classes now allow students to avail themselves of graphing calculator technology. These changes at the college level make IMP a natural preparation for calculus courses.

Is IMP rigorous enough for the top students?

Yes. This is a challenging curriculum for mathematically able students. Students are required to think, reason, and develop and apply mathematical models for real-world situations.

Some students who have been successful in a skills-based curriculum go through a period of adjustment. At first, these students may grumble because they are not given step-by-step instructions to follow. “Just tell me what to do and I’ll do it” has been a successful strategy for many students in the past. Because they are good students and are committed to doing well in school, students who may complain at first do adapt and become just as successful with IMP as they were with a traditional curriculum.

Are top students held back by heterogeneous classes?

No, not when the majority of students in the class are on grade level and come to school ready to work. For Year 1, this generally means having a class most of whose students would otherwise have been enrolled in Algebra I or above. IMP teachers find that different students do well in different units. It is not necessarily the same students who excel nor the same students who struggle and have difficulties.
Since the curriculum is built around challenging and complex problems, everyone benefits from a diversity of approaches. As students work collaboratively, the thinking skills and problem-solving repertoire of the whole class are enhanced. And for the students who want additional challenges, the IMP curriculum includes a wide range of “extension” problems for each unit.

In Conclusion

We hope you have found the information you sought by reading this guide. Should there be any other questions, please do not hesitate to contact us or IMP. Key Curriculum Press and the Interactive Mathematics Program offer our support as you embark on the exciting and worthwhile journey to assuring a high-quality mathematics education for your students.

How to Get More Information About IMP

If you are interested in bringing IMP to your school, or are currently teaching IMP and want support, the person to contact is Janice Bussey. She is the National Outreach Coordinator for the Interactive Mathematics Program and has a toll-free outreach line (888-MATHIMP) as well as an email address (jbimp@telis.org). She can send evaluation documents and connect you to a large national network of IMP teachers and regional centers.

You can get a wealth of general information about IMP by visiting the IMP Resource Center on the Web (www.mathimp.org). This website provides answers to commonly asked questions about the program, articles from past issues of IMPressions (the IMP newsletter), and program evaluation data.

The site includes an electronic version of this “Strategies” book and an updated list of colleges and universities where IMP students have been accepted. The site also provides valuable teacher resources such as the complete Teaching Handbook for the Interactive Mathematics Program and sample days from Years 1, 2, 3, and 4, including both student pages and materials from the Teacher’s Guides.
Appendix C: College Acceptance of IMP Students

Since 1993, as a courtesy to interested parents and students, the Interactive Mathematics Program has annually updated a list of four-year colleges and universities to which IMP students have been accepted. The program relies on classroom teachers to compile this information, which is volunteered by IMP students each spring as they receive their letters of acceptance. The list of colleges to which IMP students have been accepted includes state universities throughout the country as well as leading private universities such as Harvard University, Stanford University, University of Chicago, Howard University, California Institute of Technology, Yale University, and Wellesley College. To see the complete list, visit the IMP Web site at www.mathimp.org/research/college.html.

Adams State College, Colorado
Alderson-Broaddus College, West Virginia
American University, Washington, DC
Amherst College, Massachusetts
Arizona State University, Arizona
Art Center College of Design, California
Atlanta University, Georgia
Auburn University, Alabama
Augustana College, South Dakota
Barber-Scotia College, North Carolina
Barnard College, New York
Barry University, Florida
Bates College, Maine
Baylor University, Texas
Beaver College, Pennsylvania
Beloit College, Wisconsin
Bethune-Cookman College, Florida
Biola University, California
Bloomsburg State College, Pennsylvania
Boise State University, Idaho
Boston University, Massachusetts
Brandeis University, Massachusetts
Brigham Young University, Utah
Brooklyn College, New York
Brown University, Rhode Island
Bryn Mawr, Pennsylvania
California College of Arts and Crafts, California
California Institute of Technology, California
California Lutheran University, California
California State Polytechnic University, Pomona, California
California State Polytechnic University, San Luis Obispo, California
California State University, Bakersfield, California
California State University, Chico, California
California State University, Dominguez Hills, California
California State University, Fresno, California
California State University, Fullerton, California
California State University, Hayward, California
California State University, Humboldt, California
California State University, Long Beach, California
California State University, Los Angeles, California
California State University, Monterey Bay, California
California State University, Northridge, California
California State University, Sacramento, California
California State University, San Diego, California
California State University, San Marcos, California
California University of Pennsylvania, Pennsylvania
Carlton College, Minnesota
Carnegie Mellon University, Pennsylvania
Central Connecticut State, Connecticut
Central Florida University, Florida
Chapman College, California
Cheyney University of Pennsylvania, Pennsylvania
Chicago Art Institute, Illinois
Christian Brothers University, Tennessee
Claremont McKenna College, California
Clark Atlanta University, Georgia
Clark College, Georgia
Clark University, Massachusetts
Coastal Carolina University, North Carolina
Colby College, Maine
College of New Jersey, New Jersey
College of Notre Dame, California
College of Saint Rose, New York
College of Santa Fe, New Mexico
College of William and Mary, Virginia
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<td>Philadelphia College of Pharmacy and Science, Pennsylvania</td>
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Appendix C: College Acceptance of IMP Students

Introduction and Implementation Strategies for the Interactive Mathematics Program
Appendix C: College Acceptance of IMP Students

Virginia State University, Virginia
Virginia Polytechnic Institute and State University, Virginia
Virginia Union College, Virginia
Wake Forest University, North Carolina
Wanger College, New York
Washington State University, Washington
Washington University, St. Louis, Missouri
Wellesley College, Massachusetts
Wells College, New York
Wesleyan College, Connecticut
West Chester University of Pennsylvania, Pennsylvania
Western Connecticut State College, Connecticut
Western New England College, Massachusetts
Western Oregon University, Oregon
Western State College, Colorado
Western Washington University, Washington
Westmont College, California
Whitman College, Washington
Widener University, Pennsylvania
Willamette University, Oregon
Williams College, Massachusetts
Winona State University, Minnesota
Xavier University, Louisiana
Yale University, Connecticut
York College, Nebraska
Appendix D: Beginning the Change Process

The suggestions outlined below represent some of the ways in which a teacher, a school, and a district can prepare for implementation of the Interactive Mathematics Program curriculum.

- **Curriculum and Evaluation Standards:** In 1989, the National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics*. Reading this document is a good way to begin the change process.

- **Mathematics Conferences:** Attend local, state, and national mathematics conferences held throughout the school year. These are outstanding conferences where thousands of educators gather to attend sessions on mathematics reform and to network with one another.

- **Graphing Calculators:** Buy several classroom sets of graphing calculators and begin to use them in your classrooms. (Mini-grants are a good source of funding.) The College Board has approved use of these calculators on the AP Calculus exams; all the new high school mathematics curriculum projects funded by the National Science Foundation have incorporated graphing calculators as an integral part of their programs.

- **Visit IMP Schools:** The IMP curriculum is being taught at schools throughout the country. Visit one of these schools and be sure to sit with students as they work. Also look at student portfolios to see past work.

- **Student-Centered Classrooms:** Traditionally, high school mathematics classrooms are teacher-centered. There are many strategies to begin making mathematics classrooms more student-centered. One step is for you to move to the opposite side of the classroom from the chalkboard. When students present and explain their work, make sure that their classmates, and not you, are the primary audience.

- **Group Learning:** Let students talk to each other, focusing on interesting problems as they work collaboratively. Arranging students' desks into groups is a physical and psychological beginning for both students and teachers.
• **Learning for Understanding:** NCTM's *Standards* talks about focusing on problem solving and understanding of mathematics. Try to eliminate worksheets that force students to do repetitive, dull drill work. Let students create their own understanding of mathematics by working on more complex problems and asking thought-provoking questions.

• **Extended Problems:** Begin assigning a Problem of the Week every few weeks to your students. When students understand that they are being asked to solve problems in a variety of ways and to explain their thinking, they will produce impressive work. Have students make presentations of their work to the class. Problems of the Week can be obtained from a variety of commercial sources, as well as from the centerfold each month of NCTM's *Mathematics Teacher*.

• **Students as Writers:** Require students to explain in writing both their thinking processes and their solutions to all types of problems. This will help clarify student understanding.

• **Students as Risk-Takers:** Praise students for asking questions and give respect to unexpected responses. When students realize that risk-taking is valued, they will be encouraged to do more.

• **Question the Textbook:** Unless you begin to question why you are teaching what you are, the change process cannot even begin. Begin to skip some topics and spend extra time on others. See NCTM's *Standards* for suggestions.

• **Visit Feeder Schools:** Visit mathematics classes at your feeder schools and meet with their mathematics departments to talk about secondary mathematics education reform and its future in your district and region.

• **Develop Support Within Your Own School:** Invite and encourage your colleagues to visit your classroom. Ask them to focus on one or two techniques you are interested in. Meet to discuss observations. Work with your colleagues to create an atmosphere of trust and support.

• **Teachers as Learners:** Consider the possibility of learning not only new ways to approach mathematical topics that you have studied in the past, but also some mathematics topics that may be new to you. Learning along with your students is a powerful experience. Once we get over the need to know everything in advance, we free ourselves to be able to explore and question and to delve more deeply into mathematics. One of the goals is to make life-long learners not only of the students but also of the teachers.

• **Parent Night:** Invite parents to an evening of learning about changes currently taking place at your school. Discuss the direction that
mathematics education is taking and have parents participate in some mathematics learning. You will find that parents will become strong supporters for change.

• **Assessment and Grading:** You are assessing your students' work and participation in class all the time. Giving weekly mathematics tests takes 20% of learning time away from your students. Try grading student work holistically. *Measuring What Counts* (National Research Council, 1993) stresses the need for assessment to enhance mathematics learning and not to be a separate activity.

• **Talk with Administrators:** Sit down with administrators and share concerns. Talk about the direction in which the mathematics department would like to go. *Everybody Counts* (National Research Council, 1989) is excellent reading for administrators and can help to get discussions going.
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1 Shasta High School, Dave Robathan; 2 Lynne Alper; 3 Lynn Alper; 4 Shasta High School, Dave Robathan; 7 Lake View High School, Carol Caref; 12 Lynne Alper; 13 Lincoln High School, Lori Green; 17 Lynne Alper; 18 Lynne Alper; 19 Mendocino High School, Lynne Alper; 20 Lincoln High School, Dave Robathan; 21 Capuchino High School, Chicha Lynch; 22 Capuchino High School, Lynne Alper; 23 Lynne Alper; 24 Mendocino High School, Don Cruser; 25 Thurgood Marshall Academic High School, Lynne Alper; 26 Lincoln High School, Lori Green; 27 Foothill High School, Lynne Alper; 28 Napa High School, Lynne Alper; 31 Santa Maria High School, Mike Bryant; 34 Santa Cruz High School, Lynne Alper; 35 Santa Maria High School, Mike Bryant; 36 Ranum High School, Sheryl Chew