IT'S ABOUT TIME

A PLAN FOR TOMORROW'S LESSONS

Program Research

IMP™

Interactive Mathematics Program® & Meaningful Math

THE RESEARCH BASE OF IMP®: Program Effectiveness and Research Foundation

Interactive Mathematics Program (IMP) has repurposed and revised its proven content into a traditional pathway—*Algebra 1, Geometry, Algebra 2*—that fully meets the Common Core State Standards for Mathematics. These new courses are titled *Meaningful Math—Algebra 1*, *Meaningful Math—Geometry*, and *Meaningful Math—Algebra 2*. Both the *IMP* and *Meaningful Math* curricula are the collaborative effort of mathematicians, teacher-educators, and teachers working together since 1989. Developed with support from the National Science Foundation (NSF) and other funding agencies, the program was first published after more than 10 years of research, pilot testing, evaluating, field testing, revising, and detailed reviewing.

The authors drew on cutting-edge research about how students learn to develop a math curriculum that would offer students multiple ways to learn mathematics in a problem-solving context. In the classroom, the teacher's goal is to challenge students to conjecture, to build arguments, and to formulate and solve problems. Several long-term studies of student performance and participation show that the curriculum improves students' learning and increases their study of advanced mathematics. Studies conducted during the pilot testing, a comprehensive NSF-funded evaluation during field testing, and further studies of the published curriculum yield several important conclusions.

Program Effectiveness: A Broad Range of Measures

IMP teachers enthusiastically report student success, and their personal observations are supported by hard facts. The body of research cited in this section has been assessed by a committee of the National Research Council and determined to meet criteria necessary for a comprehensive evaluation of program effectiveness (NRC, 2004).[1]

An extensive set of studies—including preliminary work during pilot testing, a comprehensive NSF-funded evaluation, and numerous independent studies—demonstrated these broad findings:

- *IMP* students consistently do at least as well, and often do better, on standardized tests, compared to their peers in traditional programs.

- *IMP* students significantly outperform their peers in traditional programs on tests focused on quantitative reasoning, general problem solving, and statistics.

- *IMP* students demonstrate more positive attitudes about mathematics and take more mathematics courses, including advanced courses, compared to their peers in traditional programs.

Success on Standardized Mathematics Tests

Studies show that *IMP* provides solid experiences in the traditional mathematics core, as demonstrated by consistent performance on standardized tests. This is especially significant since IMP students spend about 25 percent of their class time studying areas of mathematics not covered by such tests. (Achievement in these other areas is discussed in the next section.) A series of quasi-experimental studies examined IMP student performance on standardized tests.

Impact of the *Interactive Mathematics Program* on the retention of under represented students: Cross-school analysis of transcripts for the class of 1993 for three high schools (WEBB AND DOWLING, 1996)

This report was part of a longitudinal, NSF-funded evaluation of *IMP* by researchers at the Wisconsin Center for Education Research (WCER). Researchers examined transcripts of *IMP* and traditional-program students at three California high schools—an inner-city school, a suburban school, and a rural school—with quite different student populations. The results applied to all:

• Among high-performing students (those in the upper quartile based on grade 7 tests), *IMP* students were more likely than students in traditional program to score 650 or higher on the mathematics section of the SAT.

• Overall, *IMP* students performed as well as traditional students on the SAT, as determined by match-group analysis and statistically accounting for prior achievement levels.

Other aspects of the WCER report and other reports in this evaluation are cited in later sections.

Impact study of mathematics education projects funded by the National Science Foundation, 1983–91 (SCHOEN, 1993)

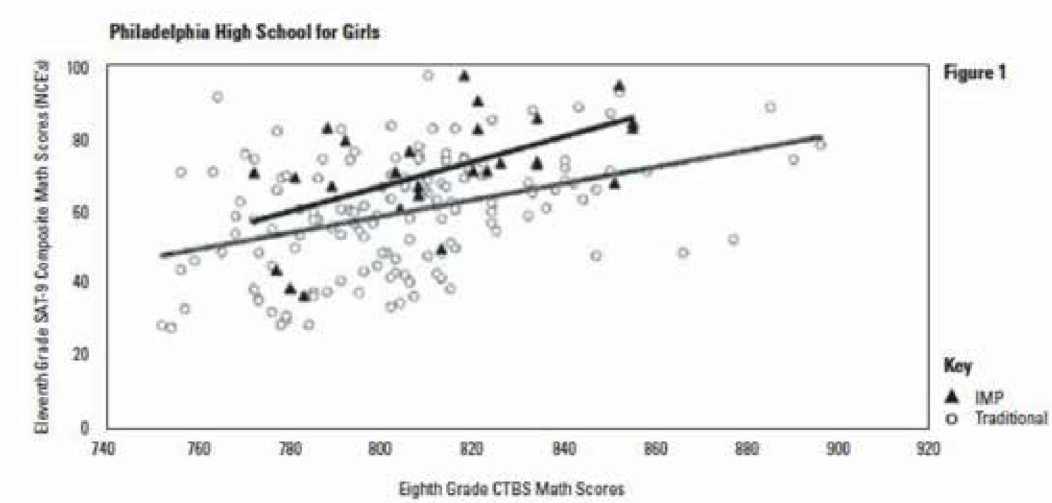
IMP was one of several NSF-funded programs examined. This study found that at some schools, *IMP* students had significantly higher SAT scores than non-*IMP* students, while at all other schools, there was no significant difference. In no cases were IMP students' SAT scores significantly lower.

Math innovations and student achievement in seven high schools in California and New York (WHITE ET AL., 1995)

This 1995 study examined the use of different mathematics curricula at high schools with low-income and low- achieving student populations. The study showed higher growth in achievement among grade 9 students enrolled in the *IMP* courses than for those enrolled in the other curricula, including traditional algebra. The *IMP* students began at a lower level than the other students in college-preparatory courses and finished at a higher level.

Summary of matched-sample analysis comparing *IMP* and traditional students at Philadelphia High School for Girls on mathematics portion of Stanford-9 test (WOLFF, 2001)

This summary of a 1996 study used the mathematics portion of the Stanford 9 test to compare two groups of grade 11 students at Philadelphia High School for Girls. The analysis used 20 composite items, each encompassing several individual questions from the Stanford 9 test. *IMP* students outperformed their counterparts using a traditional curriculum on 15 of these composite items, tied on two, and were outperformed on three. *IMP* students did better on all the cumulative scores. The 1996 study was followed by several studies that encompassed a broader student population base, including both special admissions public high schools and comprehensive public high schools in Philadelphia.



Assessing the costs/benefits of an NSF "standards-based" secondary mathematics curriculum on student achievement: The Philadelphia experience: Implementing the *Interactive Mathematics Program (IMP)* (MERLINO AND WOLFF, 2001)

In a 1997 study with grade 11 students at Central High School, a co-educational special admissions high school, student performance was measured on all 29 multiple choice items on the Stanford 9 test. IMP students outperformed traditional students on 26 items from the test and were outperformed on only three.

In 1998, a study was done to follow up on the 1996 comparison at Philadelphia High School for Girls. This research had these results:

• *IMP* students' composite mathematics scores were significantly higher than those of students in the traditional program.

• *IMP* students significantly outperformed students from the traditional program on the open-ended portion of the test.

• *IMP* students outperformed students from the traditional program on the multiple choice portion of the test, although this difference was not significant.

In 2000, a similar study was done at Carver High School for Engineering and Science. This study showed the same positive impact of the *IMP* curriculum:

• *IMP* students' composite mathematics scores were significantly higher than those of students in the traditional program.

• *IMP* students significantly outperformed students from the traditional program on the open-ended portion of the test.

• *IMP* students outperformed students from the traditional program on the multiple-choice portion of the test, although this difference was not significant.

The joint impact of block scheduling and a standards-based curriculum on high school algebra achievement and mathematics and course taking (KRAMER, 2003)

This carefully controlled longitudinal study investigated mathematics learning at a suburban high school that simultaneously adopted *IMP* and a semestered (4 x 4) block schedule. The study compared students using these changes to the school's last cohort without these changes.

Here are several key findings:

• By end of grade 11, IMP students were better able to formulate algebraic models, interpret graphs and tables, solve algebra problems presented in context, and work in pairs to solve an extended, open-ended applied algebra problem. The only area in which students in the traditional cohort did better was in their ability to translate a graph into an equation and simplify expressions with integer (but not fractional) coefficients.

• By end of grade 12, *IMP* students were achieving better than traditional students in all areas of mathematics tested, outscoring traditional cohort students on 27 of 28 publicly released items from the NAEP test. These items covered "Data Analysis, Statistics, and Probability," "Geometry and Measurement," and "Algebra and Number Sense." Within each area, *IMP* students scored higher on problem solving, conceptual understanding, and procedural items.

• *IMP* students enrolled in more AP courses and earned higher scores on AP tests compared to the traditional cohort.

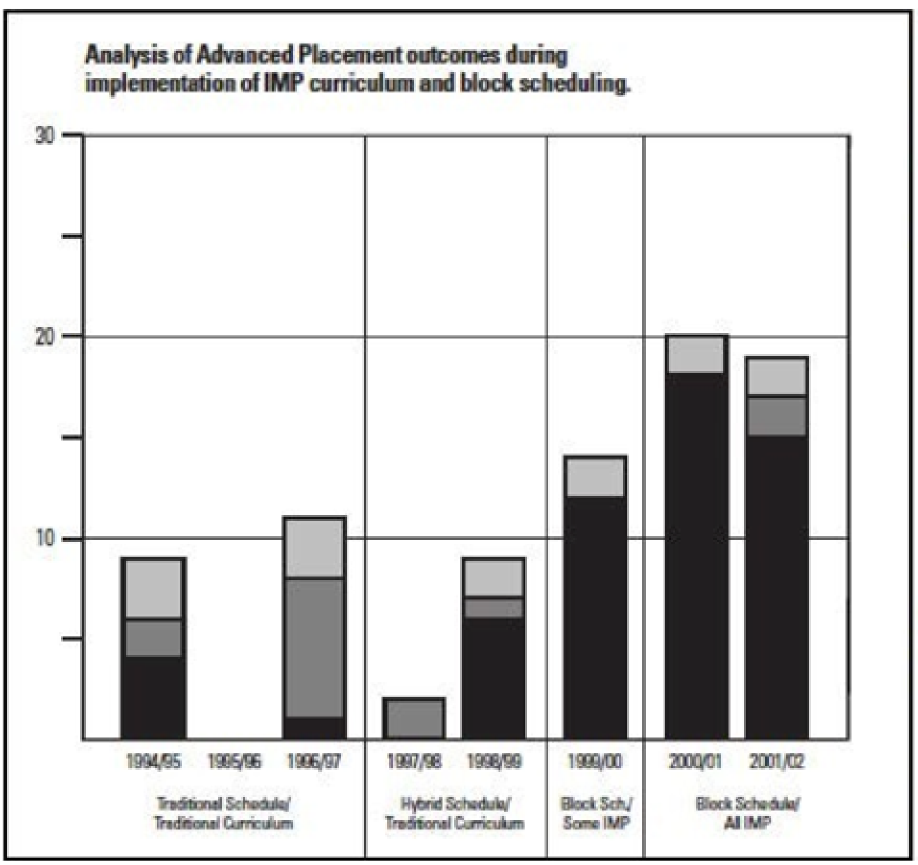


Figure 2

Block scheduling and the IMP curriculum were implemented over a three-year period. During that time, the number of students receiving the highest possible score of "5" on the BC Calculus exam increased. (Kramer, 2003)

Key

Number of Students Completing BC Calculus Exam with Passing Grade of "3" or higher.

Exam Scores: three, four, five

Other Measures of Academic Success in Mathematics

Achievement on standardized tests is only one measure of *IMP*'s success. *IMP* goes beyond the traditional curriculum to give students important knowledge and experiences with statistics, mathematical reasoning, and problem solving. Research demonstrates student achievement in these areas and shows IMP's impact on student's grades in mathematics and beyond.

Replication study of the comparison of *IMP* students with students enrolled intraditional courses on probability, statistics, problem solving, and reasoning (WEBB AND DOWLING, 1997)

This 1997 study followed up on the one just mentioned to see if the findings held up in other schools. The same grade 9 and grade 10 achievement tests were used, each at three schools that were not part of the original study. (The instrument used in the grade 11 study was not available.)

This replication study had these results:

•At two schools, *IMP* students scored significantly higher than students enrolled in the traditional program both on the grade 9 statistics test and on the grade 10 mathematical-reasoning and problem- solving test.

• At the third school, results were distorted by the fact that the traditional program was supplemented at both grade levels with material directly related to the test. At grade 9, students in the specially supplemented traditional program scored significantly higher than *IMP* students. But at grade 10, *IMP* students scored higher, but not significantly so, than students in the traditional program, despite its supplementing.

The replication study reinforced the finding that students in *IMP* learn more statistics and are better able to solve complex problems than students enrolled in a traditional program.

The other consequences of a problem-based mathematics curriculum (CLARKE ET AL., 1992)

This 1992 report examined student attitudes towards mathematics, comparing 182 *IMP* students with 217 students in traditional programs. The study found that in comparison with their peers in traditional programs, *IMP* students were more confident; were more likely to view mathematics as having arisen to meet the needs of society, rather than as a set of arbitrary rules; valued communication in mathematics learning more highly; and were more likely to see a mathematical element in everyday activity.

Comparison of *IMP* students with students enrolled in traditional courses on probability, statistics, problem solving, and reasoning (WEBB AND DOWLING, 1997)

This 1997 report, also part of the large NSF-funded evaluation of *IMP*, describes three separate studies, at grades 9, 10, and 11:

• The grade 9 study used open-ended versions of all of the statistics items from the Second International Mathematics Study, and compared grade 9 *IMP* and algebra students in a California school. The two groups of students were matched on the basis of grade 8 CTBS scores. The

IMP students scored significantly higher than the algebra students did.

• The grade 10 study used an instrument measuring students' mathematical reasoning and problem solving. The instrument was composed of two performance assessment activities designed by the State of Wisconsin. Grade 10 *IMP* Year 2 students performed significantly better than a matched group of grade 10 geometry students. These two groups were matched on the basis of grade 8 ITBS scores. Moreover, *IMP* students performed higher on the test than the subgroup of honors geometry students even though the *IMP* group had lower grade 8 ITBS scores than the honors geometry group.

• The grade 11 study used 10 items from a practice version of a quantitative reasoning test developed by a prestigious university to administer to entering first-year students. IMP Year 3 students performed significantly better than grade 11 Algebra 2 students on this test. As with the grade 9 and grade 10 studies in this report, the groups were matched on the basis of grade 8 mathematics achievement scores. *Note: The university that developed the questions would not allow WCER to use its name or to replicate the study with its items.*

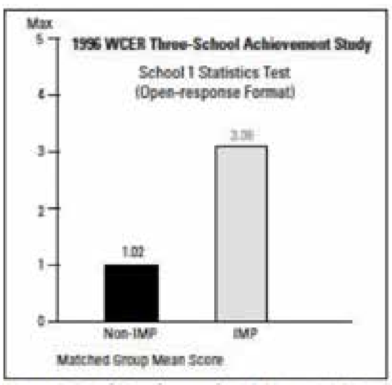


Figure 3 Grade 9 student sample: IMP 50; non-IMP 50
Differences between the IMP and the non-IMP group are statistically significant at the .01 level

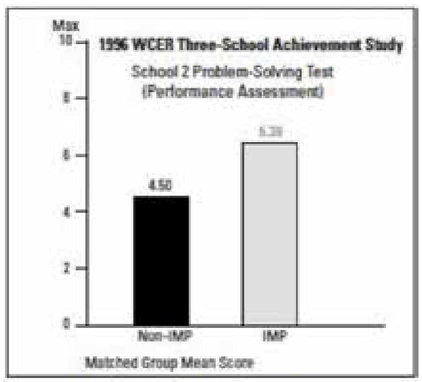


Figure 4 Grade 10 student sample: IMP 70; non-IMP 70
Differences between the IMP and the non-IMP group are statistically significant at the .01 level

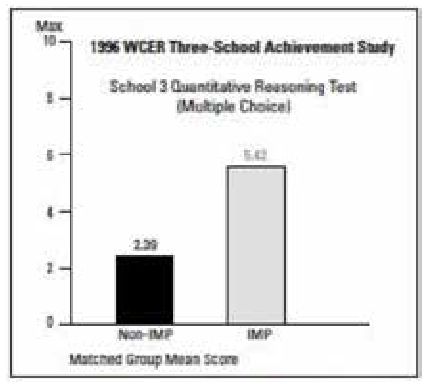


Figure 5 Grade 11 student sample: IMP 31; non-IMP 31
Differences between the IMP and the non-IMP group are statistically significant at the .01 level

Initial report: A comparison of *IMP* 1 and Algebra 1 at Greendale School, Stanford University Mathematics Teaching and Learning Study (BOALER ET AL., 2002)

This 2002 study compared students in Year 1 of *IMP* with students in a traditional Algebra 1 course. To establish a baseline, the two groups were tested at the beginning of grade 9 on topics drawn from middle school mathematics. There were no significant differences on this test, indicating that the groups in the different courses began the year with similar levels of mathematics attainment.

At the end of the year, students in both groups were given a test that assessed some of the algebraic concepts and methods to which students in the two groups had been introduced over the year. The test was designed to make sure that all students had encountered the mathematics assessed. This meant that the test assessed only algebra, even though the *IMP* students had also learned about geometry, statistics, and probability. There were no significant differences in achievement. The researchers report this as a particularly positive result for the *IMP* students. Even though *IMP* students spent only part of the school year learning algebra, they performed as well on an algebra test as students who learned algebra all year.

This study also examined the groups using a combination of other research methods, including coded videotapes, attitude questionnaires, and student interviews. Other results from this research are discussed in the next section.

Closing the Achievement Gap

Initial report—A comparison of *IMP* 1 and Algebra 1 at Greendale School, Stanford University Mathematics Teaching and Learning Study (BOALER ET AL., 2002)

This study, discussed earlier under "Other academic successes in mathematics and beyond," compared two groups of students—one group enrolled in Year 1 of *IMP*, the other group enrolled in Algebra 1. A pretest showed that the groups began the school year with similar achievement levels.

Based on interviews and questionnaires about attitudes, researchers reported these findings:

• More of the Algebra 1 students said they would try to learn new mathematics because they wanted to "get a good grade," whereas more of the *IMP* students said that they tried hard in mathematics "because the work is interesting."

• More of the Algebra 1 students agreed with the statement: "I really enjoy math class when I don't have to work hard."

• *IMP* students were much more positive about the usefulness of mathematics for their lives.

Comparison with students at another school indicated that the differences were not based on any prior differences in attitudes.

Researchers have studied teachers who use *IMP* materials in terms of efforts to increase opportunities for students to learn mathematics. In their study of teachers' attitudes toward "detracking" high school mathematics courses, UCLA researchers Jeannie Oakes and Megan Franke observed and interviewed teachers who were using traditional mathematics curriculum materials, *IMP* curriculum materials, and other integrated mathematics curricula. Their study examined data on teacher response to detracking efforts in six raciall y mixed U.S. senior high schools. Detracking refers to how schools move from assigning mathematics courses according to students' ability to designating that all courses consist of heterogeneous groups of students. "Many detracking advocates," which included *IMP* teachers, "foresaw advantages to students of color and a generally improved racial climate ...," the authors report. "Every single efficacious teacher—teachers who viewed schools and teachers as powerful agents in students' mathematics learning—was a strong supporter of detracking. In contrast, those teachers who saw students' abilities, backgrounds, and motivation as being the key determinants of successful mathematics learning were dubious, at best" (Oakes and Franke, 1999).

Another researcher observed the teaching approach of an IMP teacher and noted the benefits of the curriculum for low socio-economic student populations (Lubienski and Stilwell, 2003). In discussion of an action research project, a high school teacher reports using a unit of the *IMP* curriculum for the first time with his class. He says using *IMP* materials changed his own expectations of his students: "I came to recognize and value the variety of strategies that students employed in approaching the tasks at hand... On more than one occasion, a student offered an approach or a conclusion that I had not considered" (Evitts, 2004).

In a study of mathematics learning in the context of peer discussions, a mathematics education researcher used a student sample of nine pairs of ninth- and tenth-grade students from an *IMP* class. In a series of case studies, the researcher examined how students worked together on problems involving linear functions. Among the findings of the study was the observation that through their participation in the classroom and a short (two hour) discussion session "these students did not simply learn to use the technical terms slope and y-intercept.

Instead, they refined the meaning of their descriptions by connecting even nontechnical phrases such as 'the line will be steeper' or 'the line will move up on the y-axis' to conceptual knowledge about lines and equations" (Moschkovich, 1996)[2].

Impact of the *Interactive Mathematics Program* on the retention of underrepresented students: Cross-school analysisof transcripts for the class of 1993 for three high schools (WEBB AND DOWLING, 1996)

This study's findings on standardized tests were previously discussed. Another dimension of the data analysis addressed conclusions concerning mathematics and general academic achievement. *IMP* students achieved statistically higher mathematics and overall grade point averages than non-*IMP* students. These results held true even after adjusting for differences in prior achievement.

• At one school, data were available from grade 7 CTBS tests, and a separate analysis was done concerning students identified as high-performing, based on being in the upper quartile on these tests. Among these high-performing students:

• *IMP* students achieved higher mathematics grade point averages than non-IMP students.

• *IMP* students achieved higher overall grade point averages than non-IMP students, even when accounting for mathematics grades.

The study also included these findings on mathematics enrollment, for the overall groups and for various student subpopulations:

• *IMP* students took more semesters of mathematics, and more semesters of college-qualifying mathematics, than non-IMP students.

• For both female and male students and for all ethnic groups, IMP students were more likely than students in a traditional program to complete at least three years of college-qualifying mathematics.

• *IMP* students were more likely than students in a traditional program to enroll in advanced high school courses such as precalculus and calculus.

• Enrollment in *IMP* corresponded to a reduction in the gap between white students and black and Hispanic students in enrollment in advanced mathematics courses.

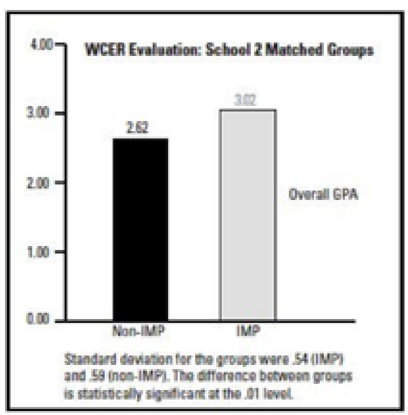


Figure 6

The IMP group of graduates achieved a significantly higher overall grade point average than the non-IMP group, based on the *Z* statistic.

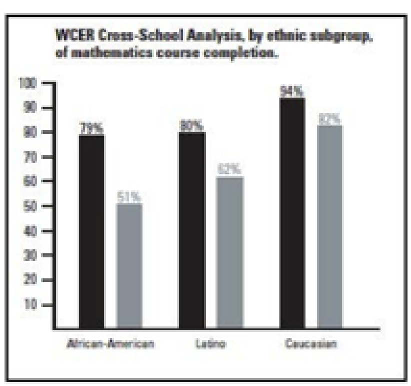


Figure 7

A statistically significant, higher percentage of IMP students completed at least three years of college-preparatory mathematics, as compared with their non-IMP peers. (Webb, 1996)

Key
Percentage of students completing at least three years of college-preparatory mathematics

IMP Students   Non IMP Students

College Admission

Unequal opportunity: student access to the University of California (MARTIN, ETAL., 2003)

A major criteria by which parents measure success is whether a program allows students to gain admission to colleges of their choice. In this study, researchers collected data indicating that the University of California, a public university system, is "disproportionately accessible to students from affluent schools in highly educated communities with largely Anglo and Asian student bodies"(p.143). They also acknowledged a notable exception, a high school in the Long Beach Unified School District where the second highest percentage of graduates are admitted to the UC system. This is a special admissions public high school with a highly diverse student population and a broad scale of socio-economic indicators. The curriculum taught at this school is IMP.

IMP has been accepted as meeting college requirements, and IMP students have successfully been admitted to hundreds of institutions of higher learning throughout the country, including the major state college and university systems, all the schools of the Ivy League, other nationally recognized schools such as Stanford and Wellesley, and historically black colleges such as Howard and Spelman. A more complete list is available online at www.mathimp.org/research/college.html.

Research Foundation

After more than ten years of research, pilot tests, evaluation, field tests, revision, and detailed reviews by professionals in the field, Key Curriculum Press published *IMP*. This solid basis made for a program that works to improve students' mathematical knowledge, skills and interest.

Everybody counts: A report on the future of mathematics education (NATIONAL RESEARCH COUNCIL, 1989)

This report called for a revision of school mathematics, with "new curricula appropriate to the mathematical needs of the twenty-first century." It assessed technology's impact on the workplace:

> The practitioner of mathematics in the computer age is more likely to solve equations by computer-generated graphs and calculations than by manual algebraic manipulations. Mathematics today involves far more than calculation; clarification of the problem, deduction of consequences, formulation of alternatives, and development of appropriate tools are as much a part of the modern mathematician's craft as are solving equations or providing answers.

This report, and others, also mandated that school mathematics be more accessible to women and underrepresented minorities. In response, state and government agencies funded the development of new approaches to high school mathematics (NCEE, 1983; Schoenfeld, 1988; NCTM, 1989). Development of the *Interactive Mathematics Program* began in 1989, funded by California state grant to create a three-year core curriculum that set "problem-solving, reasoning, and communication as major goals; include such areas as statistics, probability, and discrete mathematics; and make important use of technology" (Schoen, 1993).

In 1992, *IMP* was awarded a National Science Foundation (NSF) grant to develop the curriculum into an integrated, four-year college preparatory course sequence for high-school students. Requirements for funding included providing a core curriculum "drawn from statistics/probability, algebra/functions, geometry/ trigonometry, and discrete mathematics" and using "a full range of tools, including graphing calculators and computers." NSF criteria also call for including "situations from the natural and social sciences and from other parts of the school curriculum as contexts for developing and using mathematics" (NSF, 1991). After extensive field testing and revisions, Key Curriculum Press published the curriculum. The final volume of the program appeared in 1999.

Research on Learning

The design of the *IMP* curriculum is research-based and encompasses the following principles:

1. A curriculum that allows students to see mathematics as a useful tool can facilitate learning.

This curriculum principle is influenced by the "educational development" approach to curriculum development of the mathematician and education researcher Hans Freudenthal. "Realistic Mathematics Education" was Freudenthal's way of describing the practical investigation of mathematics, which provides students with opportunities to develop their own ways of thinking and "mathematizing," the ability to see how mathematics can be applied to real situations (Kravemeijer, 1994). The approach meets a broad range of student needs and addresses individual learning styles.

> In Freudenthal's philosophy … mathematics ought not to be associated with mathematics as a well-organized deductive system, but with mathematics as a human activity (Freudenthal, 1971, 1973)…. For curriculum development, this implies that the instructional activities should capitalize on mathematizing as the main learning principle. Mathematizing enables students to reinvent mathematics (Kravemeijer, 1994).

One way to accomplish this goal is to introduce new ideas as concretely as possible, so that the mathematics is immediately accessible to students. Many people learn more effectively using concrete approaches rather than those used in traditional mathematics textbooks (Turkle and Papert, 1992). The learner can proceed by getting involved in the details of a problem, rather than by working abstractly. Those who proceed in such a style, staying close to the initial setting, are often good problem solvers. The traditional insistence on starting out with an abstract approach to mathematics can suggest to students that their innate reasoning abilities are inappropriate and that mathematics is a subject they cannot master.

For example, consider the mathematical problem of determining the number of ways that objects can be placed in sequences or in groups. Traditional texts often introduce these permutation-and-combination problems with the abstract idea of combinatorial coefficients. However, many students have difficulty with the abstraction and prefer to describe the situation in a concrete way, such as creating a numerical list, and to reason directly in terms of the situation (Davis, 1984).

Although the *IMP* curriculum introduces topics concretely, it also encourages abstract thinking. *IMP* materials include a large collection of extension activities that allow students to go beyond the basic material. These extensions are often more abstract or involve proof or generalization.

2. A mathematics classroom in which teachers emphasize communication and language development can help students build capacity to think, reason, solve complex problems, and communicate.

IMP seeks to empower students mathematically by insisting that they describe their ideas (both orally and in writing), develop conjectures based on their own investigations, and explain how they arrived at their solutions or conclusions.

Rather than give students pre-packaged methods, *IMP* assignments actively encourage students to make sense of the mathematics and develop procedures that fit their thinking. For example, many texts give students step- by-step procedures for solving systems of equations. In contrast, *IMP* students are given freedom to work on a task in their own way—not in a predetermined way—and, as a result, come up with a variety of sound approaches. By encouraging and praising students' varied methods of solutions, teachers convey to students that their ways of doing problems are valued. When a student explains his or her approach during class discussion, other students feel comfortable exploring future problems without trying to remember the "right" approach.

3. Collaborative work in the classroom can have positive effects on student achievement and can contribute to students' productive disposition toward mathematics.

Both formal research and teacher observations indicate that active classrooms maintain the interest of many students who do not do well in traditional, passive situations (NRC, 2001). Often, maintaining an active classroom means replacing a teacher-led, whole-class discussion with a small-group activity that provides immediate engagement for students. When the activity is interesting and challenging, high-achieving students are not penalized when a whole-group discussion is replaced by a small-group activity.

In *IMP* classrooms, students regularly work in small groups. The composition of these groups is changed every two weeks or so. Over time, students learn to respect different strengths in each other. An important role of the *IMP* teacher is to make sure that one or two students do not take on all of the group's work, so that everyone can be engaged in the task at hand.

4. Studying mathematics in the context of problems motivates students to think mathematically and to make connections between skills and concepts in different mathematical topics (algebra, geometry, statistics, probability).

The *IMP* curriculum is problem-based, consisting of extended units that last five to eight weeks. Each unit is organized around a central problem or theme. Motivated by this central focus, students solve a variety of smaller problems, both routine and non-routine, that develop the underlying skills and concepts needed to solve the central problem in that unit.

> Curriculum materials in which students engage in a leading activity of design or large-scale problem solving ... are designed to recruit the informal understandings that students bring to school from other general experience so that the learning of mathematics can build from those understandings (Kilpatrick, 2003).

Motivation to learn is a key component of success. Although some students are motivated by general rationales such as "this will be on the test" or "you will need to know this next year/in college," many students need more intrinsic motivation for working on mathematics. They may find it hard to understand a task when it is stated abstractly. They may not see themselves going to college or using mathematics in future jobs. Educators need to reach these students as well as those who accept the idea that mathematics is part of their future (NRC, 2003).

In the *IMP* program, mathematics problems are put in real-life contexts. Students learn about linear programming by trying to maximize profit for a business. They learn about geometric transformations by developing a calculator program to generate a graphic display that moves on the screen. Problems are designed to capture students' imagination, such as developing a strategy for a game of chance, or figuring out when an athlete should jump from a moving Ferris wheel to land in a moving tank of water.

Field Testing: Real Students, Real Teachers

The *IMP* development team recognized that even if theoretical principles of learning are well tested through research, they do not guarantee success. The creation of a successful program also requires on-the-ground research based on actual classrooms with a wide variety of students.

Each of the four *IMP* authors either taught the curriculum or observed classes regularly in three pilot schools with diverse student populations. Each component of the curriculum went through at least three preliminary versions, with constant feedback from classroom teachers. Because more schools were added during this pilot period, the feedback encompassed even greater diversity.

With the NSF grant to expand the curriculum from a three-year to a four-year program, another full round of revision was done. The authors discussed every unit with a team of experienced *IMP* teachers who reported their success and their problems, identified potential trouble spots, and shared their solutions.

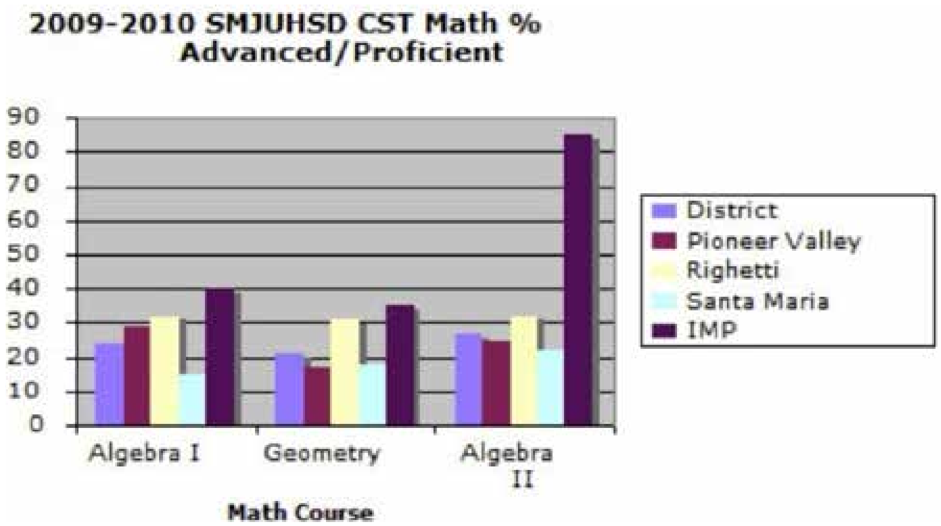
The entire revised program was then classroom-tested as a four-year sequence, so that each unit could build on what students had learned earlier in the program. Units were never tested in isolation. Once again, the feedback of classroom teachers was incorporated in order to fine-tune the details of the curriculum.

The published materials reflect all of this experience and expertise. The curriculum was published one year at a time, with Year 1 available fall 1996 and concluding with Year 4 available fall 1999.

In Fall 2002, *IMP* received an NSF grant for a second edition of its curriculum program and enhancement of its professional development network. This work was completed in 2012.

Current Data

Results continue to demonstrate that schools using *IMP* continue to outperform schools using other curricula. The data below shows results on the CST (California Standards Test) from districts using different curricula. The *IMP* students entered high school at the same place, or lower, than the other students and came from communities with significant populations of "free and reduced lunch" yet outperformed other districts using a range of other high school math curricula.



End Notes

1. Sixty-nine percent of NSF-supported ... program evaluations met basic conditions to be classified as at least minimally methodologically adequate studies for the evaluation of effectiveness. These studies were ones that met the criteria of including measures of student outcomes on mathematical achievement, reporting a method of establishing comparability among samples and reporting on implementation elements, disaggregating by content strand, or using precise, theoretical analyses of the construct or multiple measures (NRC, 2004, p. 45).

2. The researcher selected students from *IMP* classrooms not because of an interest in studying student achievement nor to evaluate the impact of the curriculum on student learning. Rather, she chose to examine mathematics learning with students accustomed to explaining their mathematical thinking while solving problems, which is a practice that the IMP curriculum encourages and teachers foster in the classroom (correspondence with researcher, 2004).

3. *IMP* materials development was sponsored by the National Science Foundation under award number EIS-9244262. Any opinions, findings, and conclusions or recommendations expressed in the IMP curriculum are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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