An American Example of High School-University Cooperation *

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Abstract

The College Preparatory Mathematics Program (CPMP) is a long-term partnership between high schools and universities designed to increase the number of students who complete four years of high school mathematics. In this talk we discuss a few of the most important ideas underlying the project.

After completing 4 years of high school at about age 17, fewer than 20% of American students have taken four years of academic mathematics. The fourth year may vary from a topics course, to college algebra and trigonometry, to calculus. Led by Professors Baldwin and Dees, the College Preparatory Mathematics Program began as a joint effort between the University of Illinois at Chicago and seven Chicago high schools to increase the number of students entering university prepared for calculus. The program now involves two other universities and an additional eleven high schools in two states. It has received funding from state, federal and private sources.

The seven schools initially selected for the program represented a wide range among the 65 high schools in Chicago. The schools vary in size from just under 1000 to about 4000 students. Two are 'magnet' schools with selective admission. The others are 'neighborhood' schools that take students

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from the immediate surroundings. In two of the schools all students are African-American; in another most are Latino.. The hallways of the other schools throng with students of all colors and races. A visitor might hear conversations in Spanish, Korean, Arabic, or a Black English dialect unintelligible to a middle class White. Many students are recent immigrants or first generation Americans.

The number of entering students who complete high school varies from 30 to 90 per cent among the schools. At the magnet schools almost all take at least three years of mathematics; at some of the neighborhood schools less than 10% normally take more than two years. However, even in the magnet schools the success rate of African-American and Latino students significantly trails the general population. Unlike the hallways, before CPMP a visitor to an advanced class would see primarily white or Asian American faces.

CPMP stresses that improvement in mathematics instruction in the schools requires a major change in teacher and student attitude. Everyone must realize that mathematics is open to all who work to learn the material not just those blessed with a special 'math gene'. The attempt to teach serious mathematics to a much larger percentage of the population than was dreamed of a generation ago demands a rethinking of high school mathematics education. The many different cultural, economic and educational backgrounds of students entering the American urban high school exacerbates the difficulty. For many students who have not reached the level of abstraction traditionally associated with college preparatory mathematics, new teaching methods are necessary to enable these students to clarify concepts. Chief among these methods are: small group learning, use of manipulatives, and emphasis on graphical and numerical means of representation as well as algebraic. Teachers become comfortable with these new methods of instruction only with sustained exposure to particular useful techniques and with the development of a support group of other teachers committed to change.

The CPMP teacher enhancement project aims to develop a core of teachers in each high school who are making this change. The program begins with a class of the best students who would not be expected to complete four years of mathematics without this intervention.

A major component of the project is the Summer Institute where teachers work with the university staff to develop new methods and materials in afternoon workshops. In the morning laboratory session they team-teach a CPMP class of students in their high school and try out these ideas. During the academic year, supported by the university staff, the teachers continue to employ these new approaches in at least one of their classes. At least one CPMP algebra class is to meet twice the usual amount of time during the year.

The project has an important impact on students, teachers, schools, and university faculty.

1. Students: The program attempts to create a peer group of students interested in mathematics. They receive additional and improved instruction both in the summer and during the academic year.

2. Teachers: Teachers develop a new style of interaction with students through the CPMP discussions of mathematics and techniques of cooperative learning. The peer group of teachers dedicated to these new methods supports teachers in their changes and encourages new leadership roles for them. Since a normal load for an American high school mathematics teacher is 5 classes each day, the time CPMP provides for teachers to discuss mathematics and pedagogy is a crucial aspect of the program.

3. Schools: The program works with teachers, counselors and administrators to increase student success in mathematics. From two teachers who use the methods part of the time, the program aims to spread through the mathematics department. That is, to create a cadre of teachers who use cooperative learning to bring out the best mathematics achievement of their students.

4. University faculty: University faculty contribute to the project expertise in mathematics and/or mathematics education. This program has significantly affected teaching practices of affiliated research mathematicians. They have learned more about the actual attitudes and abilities of their students and have adjusted their classroom behavior to some degree.

One of the teachers summarised a major effect of the program, 'Students work longer on harder problems'.

CPMP has a deliberately eclectic approach to curriculum. Materials from a number of curriculum development projects are adapted by teachers and university staff. Teachers develop both a collection of activities and the confidence to find more. The activities aim at a more conceptual rather than algorithmic understanding of mathematics. Beginning this year some of the classes are using an entirely new curriculum: The Interactive Mathematics Project. This problem-based curriculum is organized in four or five units per year each focused around one mathematical theme.

The predominant mode of instruction in American high schools might be called lecture-discussion. The teacher expounds the material while occasionally asking students rather straightforward questions to check the extent of student involvement and understanding. In contrast, CPMP emphasizes as a primary instructional strategy small-group work centered on the students' understanding of a concept. For example, the use of parentheses in algebraic expression is usually introduced by a lecture describing such rules for their use as the associative and distributive laws. In contrast, one problem from the IMP curriculum asked the students to use the numbers $1, 2, 3$ and 4 (only one occurence of each) and the symbols $+, \cdot, -, /$ to represent all numbers up to 25. Students are encouraged to check their evaluation with a calculator.

All CPMP meetings model the kind of interactive instruction that the program emphasizes. Various specific techniques for fostering group interaction (jigsaw-problems, think-pair-share, brainstorming) are demonstrated as the teachers work on a mathematical or pedagogical problem.

The complete evaluation of the project will include substantial data on student performance and reports on change in teacher methods and attitudes. Early results showed both superior performance (vis-a-vis comparison groups) on standarized examinations on mathematical content and vastly improved persistence in taking mathematics. In each school the number of students persisting into the third year was at least 10% better than the previous average. The project added at least 200 students to the pool of students taking a fourth or fifth year of high school mathematics in the 1993-94 school year. At one of the magnet schools, the year before CPMP the Calculus course contained only three minorities out of 25 students. only This year about 1/2 of 90 calulus students are minorities. This reflects both a specific intervention with 30 students and an impact of the program on the entire school. Both students and teachers discovered that minority students could succeed in mathematics.

The program has a similar impact on the involvement of teachers professional activities. There has been a dramatic increase in the number of CPMP teachers not only attending but presenting at regional, national, and international meetings. Four of the teachers now work on staff development for the program.

Now we can say at all the schools, 'The students in the advanced CPMP classes look just like those in the hallways.'