Math Beyond Computation

EQUALS inservice programs help teachers motivate female and minority students to relate math to their daily lives in useful and enjoyable ways.

Kathleen Devaney

Chocolate chip cookies” and “spinach” are labels on intersecting circles drawn on Elaine Roan’s first-grade chalkboard at Walt Disney School, San Ramon, California. The children have graphed their food preferences by writing their names inside the appropriate circles—including the section where they overlap. “They think it’s so funny,” their teacher writes in the journal she keeps about the EQUALS inservice course she is taking, “that a stranger could walk into our room and know what they like to eat just from that diagram. Using the Venns has been terrific.”

EQUALS teachers discover the answers to some startling statements about women in the workforce.

Across San Francisco Bay in Woodside School, eighth-graders imagine their futures being controlled by the roll of dice in an EQUALS activity called “Odds On You.” Working in groups and following directions similar to those in a board game, the students vicariously experience the profound difference that education—especially education in mathematics—can make on the employability and earnings of men and women. Will you be a female high school dropout and head of household, living in poverty? Will you be a soldier, a salesperson, a scientist? Your options are influenced dramatically by algebra, calculus, computer science. At the end of the activity, students ponder, “Am I satisfied with how chance decided my fate?” and “What decisions made by the dice in this game can I make for myself?”

Their math teacher, Bill Dolyniuk, reflects in his EQUALS journal on the discussion he led the day after “Odds On You.” “They began to see the difficulties of finding employment, the importance of background—that math is extremely important. They noticed that in professional jobs the salaries of men and women were about equal. And the player doomed by the dice to drop out of school to have a baby said, ‘My life is over!’”

Using dozens of activities like these, which give students mathematical ways to represent and think about their own experience, EQUALS helps teachers make math do-able, endurable—over the whole school career—and even enjoyable. The activities have been selected, adapted, and created to influence the students who are most likely to give up on math as soon as it becomes optional: girls, blacks, Hispanics. But, as Bill Dolyniuk wrote, “All the activities apply to all people. They stimulate me— a teacher with no formal preparation to teach math—to think of ways to get my point across in class as well as to make my class more interesting and productive.”

The productivity of EQUALS math inservice has been proven over six years since the program was spun off from a successful series of “Math for Girls.”

Kathleen Devaney is an education consultant and writer, Berkeley, California.
classes at the University of California's Lawrence Hall of Science in Berkeley. Almost 2,000 California teachers have taken the five-day course, which is spread over one school year and taught either at the Hall or in school districts. Begun with funding from the U.S. Department of Education women's equity program, EQUALS now receives support from the University of California for a staff of six math educators—all former classroom teachers—to conduct in-state inservice and to develop its curriculum.

EQUALS is also taught outside of California—in Seattle, Albuquerque, Philadelphia, and elsewhere. With a grant from the Carnegie Corporation of New York, EQUALS will establish six satellite training sites in other parts of the nation over the next three years. EQUALS staff members will select these sites—staff development departments, teachers' centers, science museums, and educational colleges—and provide training in how to organize and present EQUALS.

Luring the Math-Shy
EQUALS teaches a unique combination of career awareness and modern mathematics topics—spatial geometry, probability, statistics, logic, estimation, measurement, calculator and computer use, and applications of computation to nonroutine, complex problems. After a teacher learns them in one of EQUALS' tightly packed, widely varied, high-intensity workshops, EQUALS activities can be applied immediately in the regular classroom. Materials that cover the whole range of elementary and secondary math can be grasped by the whole range of teachers—from the math sophisticate to the math-shy—as well as counselors, principals, and school board members.

Long before the current national consternation about the laxness of high school requirements in math and science, EQUALS addressed the attrition of girls and black and Hispanic boys from math that is not required. EQUALS originators had to appeal with a carrot rather than a stick, to those who doubt their own talent for math, who doubt its future usefulness in their lives, or who simply get bored with basic computation that, as one teacher wrote, "never reaches the interesting level."

EQUALS' strategy was to help teachers make mathematics understandable, practical, and interesting. Besides developing lively lessons in the math topics that transcend computation, EQUALS devised game-like accessory activities that present facts about the huge role work will play in students' futures and the central role of math in the jobs of the 80s and beyond. In impressing math-indifferent or mathophobic students about the wider options that math offers, EQUALS also addresses the need of American employers for a labor pool wider than white males to perform the math-skilled work of a high-tech society.

But EQUALS also determined to make math powerful for female and minority students, who are weaker than their white male peers in math analysis and applications. Such students need early experience in "higher order thinking," not simply computation recyled throughout elementary and middle school years. Otherwise they are likely to flounder in the advanced math of high school. When EQUALS began in 1977, at the height of the basic skills era in elementary and junior high math, its focus on problem solving was the less-trod, longer-way-around path to reach and raise achievement in math. EQUALS chose this route because its goal was to retain students in math over their school career, not just raise their immediate scores on achievement tests.

Reshaping Teachers' and Students' Attitudes Toward Math
Many teachers need to raise their own mathematical thinking—and confidence—to higher levels before they can make that an instructional focus for students. As Elaine Roan—she of the chocolate chip cookies and spinach—wrote:

"Somewhere along the way in junior or senior high school I began to feel inadequate with math; actually was told that I'd have a tough time all my life with math."

Unhappily, it is common for upper elementary and middle school teachers taking EQUALS to comment that chil-
dren whose math attitudes have been shaped on the narrow frame of computation resist the stretch toward "deep understanding" and "higher-order skills." Consider these comments from teachers' EQUALS journals:

- "If an assignment does not have blank lines, little boxes, or workbook pages, some students don't know what to do. They won't even try."

- "There is a reluctance on the part of kids to tackle open-ended questions. Even so young, they only want the right answer."

- "Couldn't keep class on task. Most zipped through, got one answer, wanted to go on to a regular assignment that was going to get a grade for the grade book."

- "There were a number of roadblocks with the students: (1) The absolute hardest thing for them to do was work with a partner. (2) Reading, understanding, and following directions was difficult even for the more eager learners. Something new was totally mind-boggling to them. (3) When they finally tackled problems, I saw some skills so sorely lacking that I wished I had done some preliminary activities. For instance, sixth graders had no idea how to use a piece of string to measure! (4) Something that worked well was not giving the answer—not even knowing the answer. When frustration hit, 'I don't know the answer' made them hate me. 'But let's work together' got their attention."

Such comments, usually written between EQUALS Day 1 and Day 2, which are held successively, and Day 3 and 4, which follow about three months later, indicate the wisdom of EQUALS in scheduling its workshops throughout a school year. It combines a full-year's commitment on the part of the teachers with enough time for them to try the new activities they learn in the workshop, observe and reflect on their students' engagement with the activities, and perhaps adapt them. When teachers come back to the EQUALS leaders and other participants, they get recharged and learn more activities.

- "I think I've hurdled some of the problems. At least I keep trying, and I think the students are finally getting the idea that their teacher is not going to give up; that they are going to have to think, not just compute little numbers by rote."

- "Even though the EQUALS activities call for some computation, either mental or written, my students often say at the end of the day, 'Hey, we didn't do any math today! I think this reaction really makes several statements: (1) The students have such a great time exploring and using their creativity that they are unaware of the actual mathematical learning that is taking place. (2) The students have been previously conditioned to feel that math comes out of a textbook or workbook and that no successful learning has occurred unless this process has been taken place. (3) Students are unaware of the usage of math in everyday situations. They are taking for granted the many ways in which math is used outside the classroom. From these observations, I have developed discussion groups, so that these issues can be pondered and explored."

**Homework for Teachers**

Helping teachers themselves think and teach multi-directionally, EQUALS assigns them several kinds of homework to be done at their schools. High school participants gather and publicize data on the enrollment of girls and minorities in upper-level math in their school. Elementary and middle school teachers survey their students on what they want to be when they grow up, and have them write about an imagined day in their own life at the age of 30. (Secretary is the most frequently imagined occupation of girls; professional athlete of boys.)

EQUALS participants teach fellow teachers and parents some of the startling statistics about women's and minorities' disadvantage in employment and earnings, as well as teaching them EQUALS math activities. They bring to their classrooms or schools women and minority men who work in math-based professions or skilled trades. These people serve as role models and encourage students to think about their futures in terms of necessary and realistic work—but work with math-expanded horizons.

Such assignments help teachers convince themselves and coworkers at school of the importance of EQUALS goals and generate support for the often difficult task of inserting EQUALS into a text-and-test dominated math syllabus. These assignments also make a strong statement that EQUALS participants are not there to be "inserviced" but to join as collaborators in the effort to make math meaningful and productive for students who otherwise may be filtered out of successful careers.

Their journals reveal that many EQUALS participants identify strongly with the math-avoiding students for whom the program is designed. Again and again the program is experienced as a breakthrough for the teachers themselves. A feeling of personal achievement perhaps contributes as strongly as the practicality of the curriculum and the visibility of the workshops to the program's unusually high evaluations—mean scores of 4.5 and above on a scale of 5 in teachers' ratings of the workshops, and findings that at least 80 percent of participants apply EQUALS immediately and continually in their classrooms. It is also common for EQUALS' women participants to identify strongly—perhaps for the first time—with equity goals, both in terms of concern for their young women students and regret at their own earlier lack of choice in a career. For instance:

- "I feel the poignancy of a generation of talented females who came too early and now are being asked to teach the next generation to grasp the opportunities that are forever lost to us."

- "But they also express the elation of opportunities just opening up."

- "This has been an incredible experience for me! One and a half years ago I thought I'd be teaching English forever, and a year ago I was first experiencing the joy of math. The EQUALS project has given me math confidence, and I, in turn, have been able to instill some confidence in students. Most of all, however, it's been fun. And now, for the first time in 14 years of teaching, I'm really enjoying my work."

EQUALS staff members have written and published three books of math and careers activities: *Math for Girls and Other Problem Solvers*, SPACES; and *Use EQUALS to Promote the Participation of Women in Mathematics*. Another book, *I'm Madly in Love with Electricity*, is a collection of case studies (for students) of short interviews with women who talk about their work in science and engineering. All four books are available from the EQUALS project at the Lawrence Hall of Science, University of California, Berkeley, CA 94720.

The unattributed quotations are from the journals of the following EQUALS 1982-83 participants, all Californians: Elva Valli, Martinez Public Schools; Val Muchowski, Anderson Valley; Margaret Shelburn, Fairfield; Seena Alenick-Clark, Carolyn Howard, and Della Peretti, Oakland; and Linda Wild, Concord.