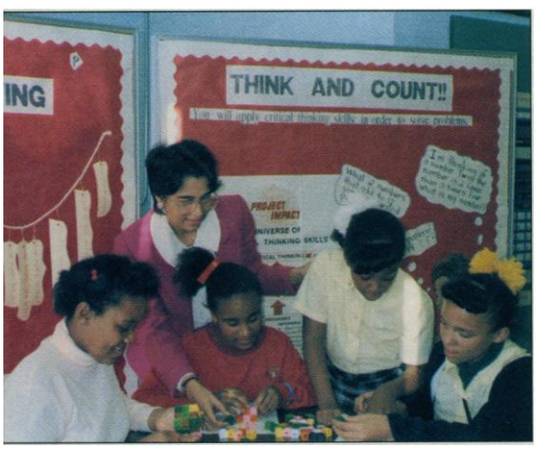
FUTURE CONDITIONAL II

Math Education: Multiplying the Meager Numbers

Model programs have found ways to unplug the pipeline, from kindergarten through grad school.

"Math is a disaster." That's how Bernard Ortiz de Montellano, long-time activist in minority education and anthropologist at Wayne State University sums up the situation for minorities in that ancient and lofty discipline. And experts like Montellano can trot out some gloomy numbers to prove the point: Underrepresented minorities fall behind whites in math skills as early as fourth grade; by high school, only 20% of blacks and Hispanics take geometry, compared to 40% of whites. By graduate school, a school like Rice University can get recognized for producing the most minority Ph.D.s. in the country—by graduating fewer than two per year.

But wait. There's a bit of good news, too: From kindergarten to grad school, a number of programs have had dramatic successes—or at least show great promise—in yielding sets of students who rise far above average in mathematical achievement. Even Hollywood stumbled over one: teacher Jaime Escalante, whose calculus class of poor Latino kids in Los Angeles was the basis for the movie *Stand and Deliver*. What the film didn't show is that for every Escalante, there are dozens of other cases where teachers and students have defied the odds. These local success stories are still too few or too new to brighten the national numbers, but they show that at every educational level, minorities can excel in math.



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—Paula Duckett

And that's important for two reasons: to swell the numbers of minorities in mathematical professions and because math is the gateway—or the barrier—to all of science. As Montellano notes, "If you're out of the pipeline in math, you're out of science for good."

So it's in every scientist's interest to identify the models for these scattered successes. And these programs do share common themes: First, they connect mathematical principles to daily life, especially in the early grades. Second, they emphasize "cooperative learning," in which students work in teams and the teacher acts more as coach than lecturer, creating a friendly environment for minorities . Finally, they start young—preferably as early as first grade.

Babes in math land. "Kids enter first grade with math as one of their favorite subjects," explains Janet Ray, expert on math education at Seattle Central Community College. But by the end of elementary school, says Ray, math is on their hit list.

To ward this off, a successful elementary class might look like Paula Duckett's fourth, fifth, or sixth grade math classes at the mostly black River Terrace Community School in Washington, D.C. Duckett, who won a 1990 presidential award for science and math teaching, says image is key. "'Math is for nerds' must be replaced with 'Math is for everyone,'" she says. "No one would ever say, 'I can't read.' That's unacceptable. But it's okay to say, 'I can't do math.'"

To show that minorities can do math, Duckett highlights black mathematicians such as Benjamin Banneker, who helped design Washington, D.C. According to Duckett, "less is more" is another part of the successful equation. It's more important for students to understand that 6 times 7 means adding together six groups of seven than to memorize times tables. Duckett also uses concrete examples with squares and bowling pins to introduce abstract concepts. The hands-on exercises let students, frequently working in groups, experience the thrill of discovery. Often "I'm in the back of the classroom and they're up front," she says. "And it works!"

Yet to do this, elementary teachers must themselves feel comfortable with the underlying concepts of math. Duckett, who admits to having had "math anxiety" like many of her colleagues, took 2 years of extra training in math education at George Washington University and is now a math specialist: Instead of teaching every subject, as is the rule in most elementary schools, she teaches only math.

Acing algebra. But imaginative grade school teachers can only increase the velocity of the children entering the pipeline. The first of the big leaks begins in middle school, when students need to take algebra to get on the science track in high school. Nearly 75% of minority students eventually take algebra, says Castello Brown of the National Science Foundation, but they often take it in 10th or 11th grade—way too late for college prep.

Enter civil rights activist Bob Moses. In 1982, newly awarded MacArthur "genius grant" in hand, Moses was dismayed by the fact that his daughter and other black children were not getting algebra in middle school. So he began the Algebra Project in Cambridge, Massachusetts. Adopted by 12 districts across the country, the program now covers grades six to eight and emphasizes a step-by-step approach.

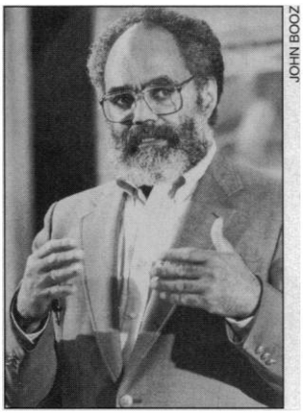
"We begin with the concrete, real-life experiences of kids and build the abstractions of math out of that," says project administrator Cynthia Silva Parker. A sixth-grade lesson on the number line (what might be called pre-algebra) starts with a ride on the local subway, with each station representing an integer. To understand circles, students first build drums, then move on to the more abstract ideas of circumference, areas, and ratios.

The results so far seem good, although the staff is only now collecting hard data. For example, at Western Middle School in Louisville, Kentucky, where 90% of the students are poor and one-third are black, the number of eighth graders who scored average or above on standardized math tests has risen from 29% to 39% in the 3 years since the Algebra Project and similar programs began, says principal Ron Barber.

But Moses may be even prouder about what's happened at King Middle School in Cambridge, his daughter's alma mater. Last year, 18 eighth graders took a test to get credit for high school algebra, and 15 of them passed. Before the project began, "very few

took the test," says Parker, "and zero—zero!—passed."

Teamwork. But then there's the second big leak: between junior and senior high school, when minorities may again be derailed by poor preparation. And so another set of programs has emerged to fill this gap. For example, Chicago's College Preparatory Mathematics Program (CPMP) recruits graduating eighth graders and gives them an intensive dose of math in the summer, followed by a double-period of algebra in the fall, all in cooperative learning style. The goal is for students to help each other and "take responsibility for each other's learning," says Roberta Dees, codirector of CPMP, which is jointly operated by the University of Illinois, Chicago, and the public school system. The teamwork gives students and teachers alike a support group in a sometimes-hostile urban environment. "The kids come to math when they cut other classes," says Dees. In its third year, CPMP has expanded to include 40 teachers and more than 600 students in grades eight to ten.



JOHN BOOZ

Determined dad. Activist Moses got math into daughter's school.

Comrades in calculus. Those precalc courses help prepare for perhaps the greatest math hurdle of all, calculus itself. There, the drop-out rate in college is often 40% for all students, and even higher for minorities. Yet a dozen programs across the country, collectively known as Emerging Scholars Programs, illustrate that it's possible to alter drastically the calculus landscape for minorities.

For students lucky enough to be in these programs, not only is the drop-out rate way down, but many have such positive experiences that they go on to become math majors. For example, at the University of Texas, Austin, 18% of the undergraduates are minorities—as compared to 23% of the approximately 500 math majors.

This past semester, 12 out of 15 students in an upper-level undergraduate class called Gaulois theory were black or Hispanic. "There weren't 12 minorities [in the class] in any decade, let alone in one semester," says Uri Treisman, another MacArthur "genius" awardee who taught the course and started the Emerging Scholars movement at Berkeley in the 1970s. And Treisman emphasizes that he's not just skimming the cream of the crop—the SAT scores and GPAs of his students are no better than the average University of Texas freshman.

What's the formula for success? In designing the program, Treisman first had to understand why minorities, especially blacks, were failing. He found that all the reasons usually cited—lack of family support, low SAT scores, lack of motivation—were either not true or irrelevant at top schools. While minorities' SAT scores averaged lower than whites, there was no correlation between their SAT scores and success in calculus.

What Treisman did observe was that blacks tended to study alone, in contrast to whites and Asian-Americans, who studied in groups. Blacks lacked an intellectual circle of friends with whom they could share math gossip—who was a good teacher and who wasn't. Affirmative action programs based outside the departments, while well-intentioned, actually hurt the students by isolating them and creating an atmosphere of inferiority, says Treisman.

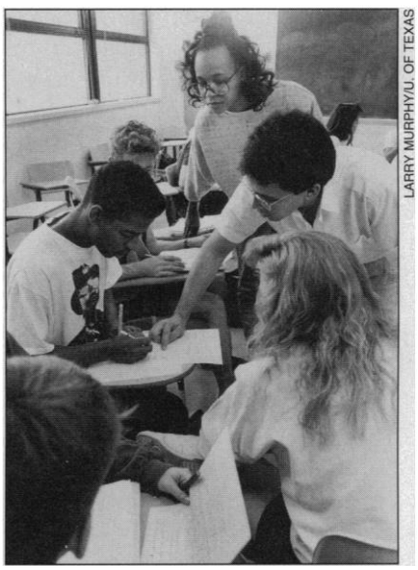
To counter the affirmative action stigma, Treisman designed his program to run like an honors class. At Texas, for example, students attend regular lectures and are responsible for all normal homework, but then go to intensive, 6-hour-per-week sections instead of the usual 2 hours per week. Any remediation that's necessary, says Treisman, is done in the context of working together on extra-hard problems. The minority students feel welcome, both because they were recruited into an honors section and because group study quickly spurs new friendships.

Final proof. The final step in the academic pipeline is graduate school, where again, more women and minorities drop out than white males. Of 461 U.S. citizens to get their Ph.D. in math last year, 10 were black, six were Hispanic, and only two were American Indian, according to the National Research Council (NRC).

Yet the applied math program at Rice University in Houston, led by Richard Tapia, defies such trends. About 25% of the graduate students are underrepresented minorities, and from 1984 until last year, not a single one dropped out. ("This year we lost one," laments Tapia.) Indeed, Tapia's program was featured—though not by name—in a recent NRC report on what works.

"He seems to know how to turn out Ph.D.s in very impressive ways," says Rhonda Hughes, math chairperson at Bryn Mawr and a member of an NRC committee that studied doctoral math programs at 10 universities. What's more, she adds, "They get good jobs and feel good about themselves."

The key, says Tapia, is a faculty that watches over its students carefully and maintains an "open door policy." Flexibility is also important: Talented students who lack the necessary prerequisites are given the time—and financial support—to make up courses. On average, women and minorities take 7 years to get their Ph.D.s; white males take less than 5 years. "We can't do magic," says Tapia.



LARRY MURPHY/U. OF TEXAS

Emerging scholars. Integrating the equation at the University of Texas.

Yet there are enough success stories in minority education to prove that magic isn't necessary. What is necessary is to make these innovative programs the norm. Most minorities are struggling along in schools with none of these programs, "in the plains between the peaks," as James Powell, president of The Franklin Institute in Philadelphia, puts it. The challenge is to give every school a chance to reach the top.

–Paul Selvin

Paul Selvin is a postdoctoral researcher in biophysics at the University of California, Berkeley.