Mathematics Achievement Among African American Undergraduates at the University of California, Berkeley: An Evaluation of the Mathematics Workshop Program

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The United States is confronting a crisis. Its customary superiority as a world leader in science, engineering and technology is eroding. One frequently cited reason for this crisis is the decline in the number of students preparing for careers in these fields. For example, the proportion of students graduating from American colleges and universities with baccalaureate degrees in science and engineering declined between 1950 and 1986 (Vetter & Hertzfeld, 1987; National Science Board, 1986). Moreover, surveys of American college freshmen continue to provide evidence that the proportion of students who express an interest in pursuing a science major in college has declined appreciably since the beginning of the 1980s (Astin et al., 1986; Green, 1989).

These changes in the nation's undergraduate science and engineering student pool are occurring at a time when these institutions are undergoing significant demographic changes. It is clear, for example, that as the United States becomes increasingly a nation of ethnic minorities, the science work force will increasingly have to come from the nation's non-White communities (Pearson et al., 1989; National Science Board, 1986). Despite increased opportunities to enter such careers, however, African Americans continue to be significantly underrepresented among undergraduate and graduate degree holders in the sciences. Thomas (1989), for example, reports that in engineering, African Americans were awarded only 3.3 percent of all bachelor's degrees, 1.6 percent of all

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master's degrees, and 0.9 percent of all doctorates awarded in 1980–81. Degrees awarded to African Americans in the biological sciences, in mathematics, and in the physical sciences followed quite similar trends.

Perhaps no single factor explains these trends better than the problems that African Americans (and other underrepresented minority students) confront in mastering mathematics. As Steen (1987) and others point out, the United States increasingly has failed to provide its students—irrespective of race—with a sufficient foundation in mathematics to meet the needs of the nation's science work force. Moreover, the mathematics preparation of African Americans is particularly poor (Marrett, 1987).

Explanations for the poor mathematics performance of African Americans abound. Frequently cited are a lack of appropriate role models, poor quality of mathematics instruction in elementary and secondary schools, and little exposure to careers in science that might motivate African Americans to exert themselves more in mathematics (Office of Technology Assessment, 1989; Marrett, 1987). The results of the National Assessment of Educational Progress (NAEP) provide substantial confirmation. Data from this national testing program compiled between 1970 and 1984, for example, suggest strongly that African Americans are (1) taking fewer mathematics courses in high school than Whites; (2) exhibiting lower level of achievement in comparable mathematics courses than Whites; and (3) entering college with skills levels in mathematics that place them at considerable disadvantage in comparison to White and Asian students (Johnson, 1984; Jones et al., 1984; Fullilove, 1987).

Since the late 1960s remedial programs have been created to serve African American and other minority students at predominantly White colleges and universities in response to the perceived—or demonstrated (via test scores)—"deficiencies" in the mathematics preparation of African American students (Fullilove et al., 1988). The principal objective of many of these programs is to strengthen students' weaknesses in mathematics skills. A typical program might include the use of tutorials, reviews of mathematical material that students presumably mastered in high school, and a great deal of drill and practice related to problem-solving techniques. However, undergraduate persistence and graduation rates reported for African Americans and other underrepresented minority students suggest that, on a nationwide level at least, these programs have not been particularly successful. They have failed to provide their students with access to careers in science and engineering, and there is little evidence that they have assisted students to graduate from college in numbers that are proportionate to their representation in each year's first-year class.

If being non-White is associated with an inability to achieve in mathematics or to persist in college, one anomaly remains: how to account for the success of Asian Americans—particularly students of Japanese and Chinese descent—in mathematics, science, and engineering. For example, 52.5 percent of all Asian American freshman plan to pursue majors in these fields as compared with 32.7 percent of all White freshmen and 32 percent of all African American freshmen (Office of Technology Assessment, 1989).

There is significant evidence that the impressive achievements of Asian students in mathematics and science have their roots in their early training and preparation for these subjects. In a 1986 study of mathematics and reading achievement of 720 first- and fifth-grade students from Taiwan, Japan, and the United States, Stevenson and colleagues (1986) reported that among the top 100 scores on a test of mathematics achievement administered to sample students in the first grade in each nation, only 15 American children were represented; among those tested in the fifth grade, only one American child appeared. By contrast, of the children receiving the 100 lowest scores in each grade, 58 were American first-graders and 67 were American fifth-graders!

Although these results do not reflect the achievement of students from the Asian American community, Stevenson's work suggests that Asian students may have much that they can teach us about assisting all students (but most particularly non-White students) to perform at optimal levels in mathematics. Described in subsequent sections of this paper is an evaluation, conducted between 1978 and 1985, of the Mathematics Workshop Program (MWP) at the University of California, Berkeley (UCB). This program, which is a component of the University's Professional Development Program (PDP), has adapted learning strategies that Chinese American undergraduates at UCB were observed to use in their preparation for first-year calculus.

The Mathematics Workshop Program: An Historical Perspective

The MWP was developed after an informal observational study of African American undergraduates and Chinese American undergraduates at UCB was conducted by one of the authors (Treisman, 1985) during the 1975–76 academic year. The study's original objective was to provide information for the design of a training program for teaching assistants (TAs) who worked with first-year undergraduate calculus students. Although many of the strategies employed by ethnographers were used in observing these students, the study was much more informal.

For example, one of the main questions that the study originally intended to answer was: What distinguishes strong mathematics students from weak students? As a first step in answering the question, TAs were asked to name their best and worst students. The names of African American students were disproportionately represented among the ranks of the weak students; by contrast, Chinese Americans were disproportionately represented among the strong students. Because strong and weak students shared one important characteristic—viz., membership in an ethnic minority group—the objective of the study shifted from examining the factors that predict success in first-year calculus to answering the question: What factors explain the differences in the performance of African and Chinese American students in first-year calculus?

Twenty African American and 20 American Chinese students who were enrolled in Mathematics 1A (First-semester calculus for scientists and engineers) were interviewed at frequent intervals during the 1975–76 academic year. Methods were devised (albeit informally) to observe students unobtrusively as they prepared homework assignments and studied for in-class quizzes and examinations.

In describing the findings of this study, our intent is less to describe the study habits of all African American or Chinese American undergraduate mathematics students but rather to provide an understanding of how the design of the MWP emerged from this year-long series of observations. The most critical finding to emerge from the study was that students in the two groups used very different strategies to prepare for examinations and complete homework assignments. African American students were more likely to study alone and to separate their social lives from their study activities. Chinese American students, by contrast, were much more likely to combine social and study time.

Specifically, Chinese American students organized themselves into informal study groups which provided them with an efficient means to accomplish a variety of tasks that are vital for survival at UCB. Twelve of the 20 Chinese American students in the study joined such groups within the first weeks of their matriculation on campus; several others who did not join such groups immediately indicated that they were looking for suitable study-mates with whom they might work. By contrast, only 2 of the 20 African Americans in the study reported studying together (and these 2, it should be noted, married at the end of the freshman year and did not return to UCB the following fall).

Observing the Chinese students at work in their groups provided many insights. Composed of students with a shared purpose, these groups enabled their members not only to share mathematical knowledge but also to check out their understanding of what was being required of them by their professors and, more generally, by the University. Among the advantages that these groups appeared to confer upon their participants were the following:

(1) Chinese students devoted approximately 14 hours per week to their mathematics study.

(2) Chinese students assisted each other with difficult homework problems; the problems that group members could not solve together were judged to be of sufficient complexity to warrant seeking the assistance of the TA.

The average amount reported by African Americans was 8 hours (an amount that mathematics professors at UCB typically recommend that students spend on their assignments). African American students typically did not seek assistance either from each other or their TA. When solutions to difficult problems could not be derived, African Americans exhibited a tendency to search for computational errors in their work and/or to seek insights by reworking textbook examples whose solutions had already been derived.

The Chinese American study groups facilitated the exchange of information between group members, and this exchange became a critical component of each student's mastery of calculus. Students checked each others' work, pointed out errors in each others' solutions, and freely offered each other any insights that they had obtained—as a result of their own efforts or through conversations with TAs or professors—

about how to manage difficult problems. Although mathematical insight may be derived from many sources, the most dramatic advantages of working in groups were observed in the ways group members corrected misperceptions or errors in their strategies for working problems.

For example, on one occasion it was observed that a study group member began to use the expression, "Let it be known that 'x' equals. . . ." Soon everyone in the group was using this expression in their written work. When one of the students discovered several days later that this usage was incorrect, he informed his study-mates of the error and the use of the expression disappeared from the group's work. Such incidents occurred regularly, and as group members became more familiar with each other, their exchange of information became extremely efficient.

The end of the first semester produced predictable results: the Chinese students generally excelled in mathematics while the African Americans, almost without exception, failed (in 1976, for example, 40 percent of the African American students enrolled in Mathematics 1A earned grades of D-plus or lower). Over the course of the next two years, the findings from this series of observations were used to construct the MWP and to adapt the best features of collaborative study for use with groups of African American and Latin students. Described below are features of that program and an assessment of the achievement of participating African American students between 1978 and 1985.

Program Description

The program in its current form is billed as an honors program that recruits first-year students of all races but typically enrolls participants of whom 80 percent are African American and Hispanic. The design of MWP as an honors program is an important part of the strategy in recruiting and motivating students. As the majority of minority students who attend UCB comprise the best and brightest of California's graduating high school seniors, they rarely come to the University with the expectation that they are skills-deficient or in need of remediation. The mean Scholastic Aptitude Test Verbal (SAT-V) and Mathematics (SAT-M) scores of UCB's first-year minority students have averaged two full standard deviations above the national means of African American SAT-takers since the beginning of the 1980s. Designing MWP as an honors program, therefore, represented a conscious effort to attract students who perceived themselves as high achievers and who would demonstrate a willingness to work to achieve academic excellence.

Prior to the beginning of each fall term, staff of the Professional Development Program identify prospective African American and Hispanic matriculants (traditionally, Hispanic students at UCB are from either Mexican American or Central American communities in California) from rosters supplied by the UCB Office of Admissions and Records. Students who indicate an interest in a career requiring mathematics are sent a letter inviting them to participate in a "faculty sponsored honors program" and to attend an orientation that describes the program in greater detail. The orientation provides staff with an opportunity to convey four simple but effective messages:

(1) MWP students are traditionally among the most successful mathematics students at the University;
(2) Some of the University's most impressive student leaders were participants in the program (including, for example, Michele DeCoteau, UCB's first ever African American Rhodes Scholar and its first Rhodes honoree in 22 years);
(3) Graduates of the program earn degrees at UCB at rates comparable to those of White and Asian students;
(4) If students pledge themselves to attend workshops regularly and to work hard, they will have a very high probability of succeeding in first-year mathematics calculus and in subsequent mathematics courses at the university.

Once enrolled, students discover that the program functions very much like the discussion section that accompanies their mathematics lectures. What distinguishes each workshop from a standard mathematics discussion section, however, is the fact that the workshop's 20–30 participants are organized into groups of 5–7 students who work together for approximately two hours, twice a week, on worksheets containing carefully constructed, unusually difficult problems. As was the case in the informal study groups of Chinese American students observed during 1975–76, today's workshop students are encouraged to discuss these problems and to instruct each other as to how solutions and proofs are derived.

The worksheets are the core of the program's efforts to provide students with three benefits: (1) the skills to earn a final grade of A in first-semester calculus, (2) a foundation in mathematics that will enable MWP graduates to continue to excel in second semester calculus and upper-division mathematics (without the assistance of the program), and (3) opportunities to identify areas in mathematics knowledge that students must strengthen to survive and excel. The worksheets are composed of problems that fall into one or more of the following groups:

(1) "old chestnuts" that appear frequently on examinations but rarely on homework assignments;
(2) "monkey wrenches"—problems designed to reveal deficiencies either in the students' mathematical backgrounds or in their understanding of a basic concept;
(3) problems that introduce students to motivating examples or counterexamples that shed light on or delimit major course concepts and theorems;
(4) problems designed to deepen the students' understanding of and facility with mathematical language;
(5) problems designed to help students master what is known, in MWP parlance, as "street mathematics"—the computational tricks and shortcuts known to many of the best students but which are neither mentioned in the textbook nor taught explicitly by the instructor.

During the workshop sessions the students' primary responsibility is to help each other to solve the worksheet problems and to understand the ideas on which the problems are based; however, there are no fixed rules regarding how students must proceed. They are free to spend part of each session working alone and they may choose the problems on which they wish to work, but they must be willing at some point during the workshop session to share their ideas and to critique the work of their peers. On average, students spend about half their time in workshop sessions working with others.

A graduate student workshop leader typically observes the functioning of these small groups as they work their way through the worksheets. Through monitoring the discussions of student participants, the leader can determine how well each student has mastered key principles and can assist students (with a carefully planted hint or suggestion) to work their way through any difficulties they encounter. Because MWP students are asked to exhibit the same skills they will later have to demonstrate on quizzes and examinations, the "practice-with-feedback" process that occurs in each workshop is uniquely suited to provide students with the tools to perform at optimum levels of proficiency. The results of these efforts are described in the next section of this article.

MWP EVALUATION: 1978–84

Data Sources

Since the inception of MWP the PDP staff has been interested in monitoring the academic achievement of campus minority students. To facilitate this process, PDP developed a computerized data base (URISHIRA) which is an SPSSx data file containing extensive demographic, registration, and grade information on African American undergraduates. The data described here include information on African American students who began their studies at UCB between fall 1973 and fall 1984, inclusive. Data were derived from five sources: (1) the University Registrar's Information System (URIS), (2) the Office of Admissions and Records, (3) the Student Learning Center, (4) the Office of Information and Records' "Courses of Instruction by Department—Grade Summaries," and (5) the Administrative Information Systems Office (AIS).

Population Sample

The population described herein includes 646 African American undergraduates who entered UCB and enrolled in Mathematics 1A between 1973 and 1984. The best grade earned by each student in any attempt to complete Mathematics 1A during the first two-and-one-half years at the University was recorded. Students enrolled in the University's self-paced version of Mathematics 1A were also included in these data. Students who did not complete the course to earn a grade were not included; thus, students earning grades of incomplete, pass, and not pass were ignored.

Achievement was analyzed according to students' categorization in a variety of groups related to their enrollment at the University. The term "workshop student," for example, was used to describe any student who attended at least three workshop sessions during any three-week period of the semester. Included in this group, therefore, are both students who attended one session per week for three consecutive weeks as well as students who attended one session at least once per week during three nonconsecutive weeks in the semester. Such conservative classification allowed for the inclusion in the MWP group of a small number of students who enrolled in the program but declined to attend further after a few sessions. As these minimal attenders were uniformly weaker performers than those who attended regularly, their inclusion in this category serves to understate the effect of continual attendance in the program as well as the overall impact that the program may have had on persistence and academic performance. Other categories were based on admission status (i.e., students were categorized as "special admits" or "regular admits" depending on whether or not they were admitted to the University using its regular admissions criteria; and as either educationally or financially disadvantaged [Educational Opportunity Program participants]). Because the College of Engineering at UCB is the most academically rigorous and prestigious of its five colleges, the population sample was also analyzed by students' status as engineering or non-engineering majors.

Evaluation Design

The objective of the evaluation was to assess the degree to which the MWP has had an impact on the mathematics performance and persistence of participating students, as measured by a comparison of final Mathematics 1A grades earned by MWP and non-MWP students. The findings from such a comparison, however, are confounded by a variety of important factors. First, MWP students represent a self-selected group; students are not required to participate in the program and cannot, therefore, be assigned to either a treatment or control group. Thus, any ostensible treatment effect associated with membership in MWP might easily be explained as a function of differences in the level of motivation possessed by participating students (or in some other unmeasured intervening variable that is correlated with both choosing to join such a program and success in mathematics).

Although we were unable to approximate the key characteristics of a traditional evaluation design, our analysis strategy was constructed to test a variety of hypotheses that might explain any observed differences between MWP and non-MWP students. We tested the assumption that an effective program would produce similar levels of achievement on the part of all students, irrespective of differences in aptitude for mathematics (as measured by SAT Mathematics scores), admissions status, or membership in the EOP. As low SAT-M scores and special admissions or EOP status traditionally have been associated with sub-par performance in mathematics and with a high risk of failing to complete an undergraduate degree, comparing workshop students in each of these groups to non-workshop students provides a reasonable test of the workshop program's effectiveness.

To control for selection artifacts—that is, differences in Mathematics 1A final grades that might be explained because MWP participants self-select membership in the program—we examined three distinct periods in MWP's history. The first covers the years 1973 to 1977, prior to the establishment of the program. This period provides us with a baseline data about the performance of pre-MWP African American students. In other words, this first era provides us with an historical control group against which to measure the subsequent performance of MWP students. The second era covers the period between 1978 and 1982, a period when MWP was created and financed with a grant from the U.S. Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE). During this three-year period MWP was administered by both PDP and the University's Student Learning Center and it served 57 percent of all African American students completing Mathematics 1A. The third period includes the era from the fall semester 1983 to the fall semester 1984 (inclusive), when FIPSE funding expired and MWP was managed exclusively by PDP. During those two years, PDP was only able to finance a much more modest program (serving only 23 percent of all African American Mathematics 1A grade earners).[1]

Statistical Analysis

In this analysis we examined various sub-groups of MWP students and non-MWP students who entered UCB in 1978–79. The chi-square test was used to test the association between group membership (e.g., MWP special admits versus non-MWP special admits) and the following three outcome measures: (1) earning honors level grades in Mathematics 1A (defined as a final grade of B-minus or better); (2) earning failing grades in Mathematics 1A (defined as a final grade of D-plus or less); and (3) persisting in the University (defined as either graduating or being in good academic standing in the fall 1985 semester).

RESULTS

Failure in Mathematics 1A

Table I shows the proportion of African American students who earned failing grades in Mathematics 1A between 1973 and 1984. A total of 131 African American students completed the course in the five-year period between 1973–77; by contrast, the succeeding five years saw a dramatic increase in the numbers of African Americans both enrolled in and earning grades in this course. While the failure rate among students in the historical control group (33 percent) does not differ statistically from those in the non-MWP group in 1978–82 (40 percent) or in the non-MWP group in 1983–84 (41 percent), the failure rate among MWP

[1]These differences in the size of the program's enrollment suggest that participation in MWP traditionally has been more a function of the program's funding than of the motivation of individual students to attend. Accordingly, we were particularly interested to determine whether the mathematics performance of MWP students varied during these two funding eras—our assumption being, of course, that if performance levels did not vary from one era to the next, one might reasonably assume that the program's content (rather than its size or the characteristics of its students) accounted for any observed differences in student performance.

TABLE I

Proportions of African American Students Receiving Grades of D-plus or Lower in First-Year Calculus, by Year of Entry

Year of entry	Non-MWP Participants	MWP Participants
	Pre-MWP	
1973	31% (5/16)	
1974	43% (9/21)	
1975	27% (7/26)	
1976	40% (12/30)	
1977	26% (10/38)	
	FIPSE Era	
1978	52% (14/27)	4% (1/23)
1979	24% (7/29)	0% (0/33)
1980	45% (17/38)	0% (0/38)
1981	38% (8/21)	2% (1/40)
1982	39% (11/28)	6% (3/54)
	Post-FIPSE Era	
1983	35% (24/69)	10% (2/21)
1984	47% (34/72)	5% (1/22)
	Period Aggregates	
1973–77	33% (43/131)	
1978–82	40% (57/143)	3% (5/188)
1983–84	41% (58/141)	7% (3/43)

students in both the 1978–82 period (3 percent) and in the 1983–84 period (7 percent) did differ quite significantly from that of all three groups of non-MWP students. (Each analysis was significant at $p < 0.0000$.)

MWP is an honors program whose objective is to promote the highest levels of academic achievement possible. As shown in Table II, when the proportions of students earning grades of B-minus or better are compared by year and by membership in MWP, dramatic, statistically significant group differences emerge: MWP students were two to three times more likely to earn grades at this level of achievement than non-MWP students, irrespective of the year enrolled. (All analyses are significant at $p < 0.01$.)

Program size appeared to have had no impact on student achievement: in 1982, for example, of 54 students enrolled, 61 percent earned grades of B-minus or better. In 1983, when the program only served 21 students (less than half the number served in the previous year), 12 students (57 percent of the total) earned comparable final grades.

Comparison of Achievement by Subgroups

Table III shows academic achievement among various subgroups of African American Mathematics 1A students. Irrespective of how MWP and non-MWP students are subdivided, however, two trends emerge: (1) when MWP students and non-MWP students within a given category

TABLE II
Proportions of African American Students Receiving Grades of B-minus or Higher in First-Year Calculus, by Year of Entry

Year of entry	Non-MWP Participants	MWP Participants
	Pre-MWP	
1973	25% (4/16)	
1974	10% (2/21)	
1975	35% (9/26)	
1976	13% (4/30)	
1977	26% (10/38)	
	FIPSE Era	
1978	4% (1/27)	39% (9/23)
1979	28% (8/29)	55% (18/33)
1980	18% (7/38)	58% (22/38)
1981	10% (2/21)	50% (20/40)
1982	18% (5/28)	61% (33/54)
	Post-FIPSE Era	
1983	26% (18/69)	57% (12/21)
1984	19% (14/72)	59% (13/22)
	Period Aggregates	
1973–77	22% (29/131)	
1978–82	16% (23/143)	54% (102/188)
1983–84	23% (32/141)	58% (25/43)

are compared, MWP students significantly outperformed their non-MWP peers, and (2) even those MWP students generally presumed to perform poorly (e.g., EOP students or special admits) outperformed non-MWP students from presumably stronger backgrounds. The most significant demonstration of this trend can be seen when the groups are examined by SAT Mathematics scores. Among both MWP and non-MWP students the probability of earning a grade of B-minus or better is significantly correlated with SAT-M scores; however, when MWP students with SAT-M scores in the lowest triad of the score distribution (i.e., scores between 200–460) were compared with non-MWP students with scores in the highest triad (i.e., scores between 560–800) there was no significant difference in the proportion earning final grades of B-minus or better. Overall, irrespective of the time period examined or the manner in which students were grouped, MWP students in any given enrollment category were two to three times more likely to earn grades at the higher score level than non-MWP students in comparable categories.

Persistence and Graduation

Table IV shows the persistence and graduation rates of MWP and non-MWP students who entered UCB in the 1978–79 school year. The proportion of MWP students who had earned degrees or who were still

TABLE III

Proportion of African American Students Earning Grades of B-minus or Better in Mathematics 1A Among Selected Sub-Groups of Students: 1973–77, 1978–82, and 1983–84

	Historical Control Group (1973–77)	MWP Participants (1978–82)	Non-MWP Participants (1978–82)	MWP Participants (1983–84)	Non-MWP Participants (1983–84)
All African Americans Taking Math 1A	$N=131$ 22%	$N=188$ 54%	$N=143$ 16%	$N=43$ 58%	$N=141$ 23%
Admissions Status:					
Spec. Admits	(4/46) 9%	(20/47) 43%	(4/59) 7%	(2/8) 25%	(9/44) 21%
Reg. Admits	(25/85) 29%	(82/141) 58%	(19/84) 23%	(23/35) 66%	(23/97) 24%
EOP Status:					
EOP	(11/78) 14%	(38/77) 49%	(3/41) 7%	(5/9) 56%	(5/36) 14%
Non-EOP	(18/53) 34%	(64/111) 58%	(20/102) 20%	(20/34) 59%	(27/105) 26%
College:					
Non-Engineer	(22/91) 24%	(59/122) 48%	(18/121) 15%	(16/30) 53%	(22/112) 20%
Engineer	(7/40) 18%	(43/66) 65%	(5/22) 23%	(9/13) 69%	(10/29) 34%
Sex:					
Male	(17/77) 22%	(57/98) 58%	(12/81) 15%	(15/24) 62%	(17/83) 20%
Female	(12/54) 22%	(45/90) 50%	(11/62) 18%	(10/19) 53%	(15/58) 26%
SAT-Math Triad*:					
200–460	(8/43) 19%	(17/56) 30%	(6/47) 13%	— —	(3/37) 8%
470–540	(7/35) 20%	(29/54) 54%	(6/35) 17%	(8/17) 47%	(7/32) 22%
550–800	(11/41) 27%	(46/65) 71%	(10/42) 24%	(16/22) 73%	(18/58) 31%

Note: The subgroups are not mutually exclusive (e.g., EOP students may also have been engineering majors).

*A tripartite division of students by SAT-Mathematics scores was created by dividing all students in the study into three groups of approximately equal (33.33%) proportions.

TABLE IV

Persistence and Graduation Among African American Mathematics 1A-Takers, by Year and by MWP Membership*

	Historical Control Group (1973–77)	MWP Participants (1978–79)	Non-MWP Participants (1978–79)
All African Americans Taking Math 1A	*N*=547 39%	*N*=72 65%	*N*=209 41%
Admissions Status:			
Spec. Admits	27% (79/297)	58% (14/24)	33% (30/91)
Reg. Admits	53% (133/250)	69% (33/48)	46% (55/118)
EOP Status:			
EOP	33% (118/356)	60% (24/40)	38% (45/119)
Non-EOP	49% (94/191)	72% (23/32)	44% (40/90)
College:			
Non-Engineer	38% (189/497)	71% (37/52)	41% (80/194)
Engineer	46% (23/50)	50% (10/20)	33% (5/15)
Sex:			
Male	34% (76/221)	70% (23/33)	37% (38/104)
Female	42% (136/326)	62% (24/39)	45% (47/105)
SAT-Math Triad:**			
200–460	36% (96/251)	58% (14/24)	33% (33/100)
470–540	47% (46/98)	59% (10/17)	48% (13/27)
550–800	48% (38/79)	77% (17/22)	49% (17/35)

Note: The subgroups are not mutually exclusive (e.g., EOP students may also have been engineering majors).

*Refers to all students who had either graduated or were still enrolled at UCB as of the fall 1985 semester.

**A tripartite division of students by SAT-Mathematics scores was created by dividing all students in the study into three groups of approximately equal (33.33%) proportions. SAT scores are not availabe for all students in the sample.

enrolled in a mathematics-based major by the spring 1985 semester was 65 percent. The comparable rate among non-MWP students who entered the university during this period was 41 percent, and the rate among African American students who entered the university in 1973 was 39 percent (both comparisons are significant at $p < 0.001$). Of particular significance, the proportion of MWP persisters with SAT-M scores in the lowest triad of the score distribution was higher than the proportion of non-MWP persisters with SAT-M scores in the highest triad from the same time period. MWP students from the lowest triad group also persisted at rates higher than those of African American students in the historical control group with SAT-M scores in the top triad.

Discussion

The data clearly suggest that MWP has succeeded in achieving its primary objectives. Its success in promoting high levels of academic performance among African American mathematics students during a period when fully 57 percent of such students were enrolled in the program is particularly worthy of note.

Subsequent qualitative evaluations of the program have established a number of hypotheses to explain why MWP students have been successful. First, the workshops create academically oriented peer groups whose participants value success and academic achievement. As students achieve success in a subject that they typically find daunting, they become committed to maintaining their success. Similarly, because success is highly prized, students commit themselves to work hard to achieve it. Estimates are that workshop students spend 10 to 14 hours per week on their mathematics studies; the comparable estimate for non-workshop students is 6 to 8 hours (Asera, 1988). This commitment to hard work provides the foundation for the second hypothesis offered to explain MWP student success: that students spend more time on learning tasks. Because the workshops ensure that this time is efficiently spent, workshop students achieve at higher levels than non-workshop students with ostensibly better backgrounds in mathematics.

Finally, although the Professional Development Program only offers the MWP workshops to first-year students, participants are believed to persist in college longer than their non-workshop peers because they acquire social and study skills in the workshop setting that they use throughout their college careers. They become connected to a social network of past and present PDP students. Through these networks they also become connected to the wider college community. Studies of high school and college attrition have shown that such commitment to an institution is a critical characteristic of persisting students at both the undergraduate and secondary school level (Pascarella, 1980; Finn, 1989).

MWP has not only demonstrated a capacity to succeed at a highly competitive, top-ranked university, the model has also proven to be highly adaptable by other institutions. The MWP model has been successfully adapted at a number of undergraduate institutions including the University of California at Los Angeles, the University of California at San Diego, and California Polytechnic at Pomona. In each of these programs the levels of achievement of African American and other minority students closely approximates (or exceeds) the success rates described herein for UCB participants. The model has also been adapted for use with first-year medical students at the University of California, San Francisco with considerable success (Fullilove et al., 1988).

As the nation attempts to improve the academic achievement of African American students and improve their access to mathematics-based careers, the findings offered here certainly warrant careful consideration. MWP has not only demonstrated a capacity to succeed in promoting high levels of academic achievement for minority students at a competitive, top-ranked university; the model has also proven to be highly adaptable by other institutions as well. Although this article has focused largely on the program's effort to assist undergraduate students, it should also be noted that MWP has also been successfully adapted for use with high school students. Anti-academic peer pressure—specifically, the fear of being perceived as a "nerd" or a "square"—frequently has been identified as one of the root causes of school failure for secondary school students of all races (Finn, 1989). Thus, programs that can redirect the energy of such peer groups into positive pursuits and that can establish academic achievement as a source of pride deserve greater attention.

Certainly, the results presented herein suggest that it is possible to create academically oriented peer groups and that their impact can be dramatic and quite powerful. We conclude, therefore, that as the nations attempts to improve the access of minority students to mathematics-based careers, MWP's methods and its success certainly warrant close, careful consideration on the part of educators and policymakers alike.

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