THE MATH EXCELLENCE WORKSHOP

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ABSTRACT

This paper describes the first two years of the Clemson University College of Engineering's Math Excellence Workshop, a program administered by Westinghouse Electric Corporation, Savannah River Site, and funded by the Department of Energy. The objective of the program is to prepare minority students for technical/scientific study, with the goal of increasing minority retention in the College of Engineering.

Twenty-three African American students, all of whom had been accepted into the College of Engineering Fall 1990 freshman class, took part in the first year of the program. The contract paid for room, board, tuition, fees, books, and supplies for the students to live on campus and take a precalculus math course. In addition, the students attended a special honors workshop designed to prepare them to study technical material effectively.

Twenty of the 23 students earned As or Bs in the precalculus class. All participants indicated that they felt confident of their ability to succeed academically at Clemson. At the end of the session, twenty of the students were still planning to major in engineering.

The program was repeated the following summer with 24 students from the 1991 freshman class. Twelve of the students earned A's or B's in the precalculus class.

BASIS OF THE PROGRAM

Research conducted by Dr. Philip Uri Treisman at the University of California, Berkeley Division, indicates that one factor in the scholastic success of Asian and Asian American students is their comfort with the process of group study. Group study is an extremely effective method for understanding technical material: in the process of explaining and defending their methods of problem-solving, students arrive at a much more sophisticated understanding of the material than they can achieve alone.

Asian and Asian American students are comfortable with this method by the time they enter college. Further, they easily combine group study with digressions to social and college adjustment topics, a supportive process which eases their entry into a new environment.

In contrast, Dr. Treisman found, African American students who are successful in high school tend to study in isolation. Academics and social interaction are kept strictly apart. These students begin college never having participated in group study and having no appreciation of its effectiveness.

Berkeley combats this problem by offering an honors workshop in calculus. Students work in small, informal groups on math that is more challenging than the math they are learning in the regular classroom. Their ability to succeed with challenging material boosts their confidence in their academic abilities, and the extra math work dramatically improves their grades in the regular calculus class. The casual and supportive atmosphere of the workshop helps increase their ability to deal with the University environment. The calculus grades earned by these Berkeley workshop students graphically demonstrate the value of the program.

MATH EXCELLENCE WORKSHOP (MEW) PROGRAM DESIGN

All Clemson engineering freshmen who do not earn a grade of 550 or higher on the Math Level II Achievement Test (MA II) or a grade of 3 or better on the Advanced Placement (AP) Exam are required by the University to take MTHSC 105. This is the algebra/trig class that precedes the required four-semester calculus sequence. MTHSC 105 is both a challenging and a swift-paced course, one in which many would-be engineers flounder. We therefore reasoned that our most effective intervention would be to base our workshop around this precalculus course, and thus ready underprepared students for freshman calculus.

In the summer session, MTHSC 105 lecture and lab take up most of each weekday morning. Two sections of the course are offered by the math department, and we split the MEW students up between the two sections. We hope that by doing so, we give them some opportunity to interact with white students. We also want to emphasize to them that the Workshop is not an adjunct to the MTHSC 105 class.

The students attend the Math Excellence Workshop for two hours every afternoon. Each day they complete a worksheet consisting of highly challenging math problems. The topics covered by these problems roughly parallel those covered in MTHSC 105.

We expect the students to gather in small, informal groups to work on the worksheets together. The instructor is available to answer questions during the workshop, but *not to provide* formal instruction. In addition, periodic coaching in study skills is offered during Workshop hours by the coordinator of the Minority Engineering Program.

ADDITIONAL PERSONNEL

Two senior African American engineering students live in the dorms with the MEW students to provide informal mentoring and counseling. They organize two social events for the students (a movie-and-pizza party and a bowling night). They are asked to provide a friendly ear but not to chaperone the MEW students, who, after all, will be regular college students in a month's time. They attempt to encourage

students to plan regular study hours and to get enough sleep, but participants are expected to be responsible for themselves.

An African American graduate student serves as a resident tutor to help the students with MTHSC 105 homework. He holds "office hours" for two hours every evening. Students are expected to drop in when they have questions.

SELECTION OF PARTICIPANTS

We determined to offer the Workshop to all incoming African American engineering freshmen who had scored 550 or less on the math portion of the Scholastic Aptitude Test (SAT). This gave us a pool of 65 potential participants the first year, from whom we hoped to pull a maximum of 23 students.

We sent a letter describing the program to the eligible students, along with a self-addressed, stamped card they are to return. The card has three choices of response:

> Yes, I want to attend the workshop. I understand there will be only 20 participants.
>
> No, I cannot participate.
>
> No, I cannot participate because I have scored 550 on the mathematics achievement test or gotten 3 or more on the AP Calculus Test, and my first mathematics course will be calculus.

We received 23 affirmative responses, five "cannot participates," and four cards indicating high MA II or AP scores. Three of the affirmative responses were later changed to negatives. However, three students who had not received the mailing (because their math SAT scores exceeded 550) but who were required to take MTHSC 105, asked to be included in the program. We determined that we could accommodate all 23 remaining students.

VARIATIONS ON THE ORIGINAL PROGRAM DESIGN

Although we had not originally expected to do so, the demand on the instructor during Workshop sessions is so heavy that we employ our tutor to assist her in addition to his evening tutoring hours. Both of them are needed to answer students' questions, suggest alternative approaches, and provide encouragement and support. It appears that two resource people are the minimum number needed for a group this size.

We had intended that the workshop instructor not do any formal teaching but simply be available as a resource during the workshop. In practice, Mrs. Garner finds it necessary give some five- and ten-minute "mini lectures," either because one section of MTHSC 105 is behind the other or because the class had failed to cover some concept she felt might be crucial to the students' future comprehension of calculus. Some of the topics covered in mini lecture include limits, partial fraction expansions, and solving equations involving inverse trig functions.

To vary the workshop format, the instructor also invites individual students to the blackboard to explain their approaches to solving a few of the most challenging problems. Some of the students have commented that they find this extremely helpful.

Another unplanned occurrence is that the tutor's nightly two hours of tutoring has become in practice a 24-hour-a-day job. MEW students ask him math questions at meals, parties, whenever and wherever they happened to see him. Fortunately, he enjoys the students.

NORMAL PROGRAM FUNCTION

The students attend Workshop from 2:30 to 4:30 pm each weekday. They pick up worksheets from Mrs. Garner as they enter the room, and gathered in groups of two to six people to begin work. The worksheets are designed to be longer than most students can finish in one session, so that even the most able students are challenged. The majority of students choose to begin a new worksheet each day, but some refuse to move on to a new one until they have completely finished the current one.

The atmosphere, as was intended, is very informal. Fruit punch is provided every day, and the students get up to serve themselves whenever they wish. The instructor and the tutor circulate between the groups, answering their questions. The Minority Engineering Program Coordinator comes in and out of the room to be available to help with "housekeeping topics," such as phones, housing, and infirmary visits, and also to answer questions on topics such as fall registration, scholarship opportunities, and other facets of campus life. Conversations between the students range from lively discussion of the math problems in question, through plans for social events, to comparing notes on fall class schedules.

The students seem comfortable with the group study format. They do not need to be coaxed to work together or taught how to do so. Rather, it seems that, having been given a situation in which it is socially acceptable to discuss academic topics, they are willing and eager to do so.

FIRST YEAR RESULTS

Based on the results achieved by the University of California at Berkeley we had expected significant success, but the results the first year were really outstanding. Of the 23 participants, 20 earned As and Bs in MTHSC 105.

The final breakdown was:

14	As
6	Bs
2	Cs
1	D.

One of the As was earned by the woman who had the group's lowest math SAT score, a 360. The average math SAT score for MEW participants was 478.

The 37 MTHSC 105 students who were not in the MEW had an average math SAT score of 498. Their final grade breakdown was:

4	As
14	Bs
11	Cs
0	Ds
3	Fs
5	Withdrawals.

It is safe to assume that the students who withdrew were failing the course, since all of them had taken at least two tests.

Thirty-minute pre- and post-tests, designed by the instructor, were administered to the Workshop students. The average pretest score was 2.76 out of 20; the average post-test score was 7.4 out of 20.

SECOND YEAR RESULTS

The second year results were not so spectacular, although the MEW students still significantly outperformed those who were not in the workshop. Twenty four students participated in the MEW in August 1991,

The final grade breakdown was:

8 As
4 Bs
8 Cs
4 Ds
0 Fs.

The grade distribution for the 37 MTHSC 105 students who were not in the workshop was:

6 As
11 Bs
7 Cs
6 Ds
7 Fs.

STUDENT COMMENTS

At the end of the workshop each student is given a series of open-ended questions intended to reveal students' understanding of the purposes of the Math Excellence Workshop and to assess their commitment to using group study techniques in the future. Samples of their responses follow:

"Before participating in the MEW I never could talk and explain math. The reason was always, 'because it's just like that.' But now I am able to understand and explain math. ... I think the workshop is truly a great success. I was always a C student in high school math because no one explained it to me. But here I am an A student because I can explain it myself."

"I have learned that I should know my lesson and not just memorize it for a test."

"This workshop helped me to build up my confidence in becoming an engineer."

"I would like to thank Westinghouse for this opportunity to take MTHSC 105. I'm sure this will be a stepping stone to my engineering career."

"The Math Excellence Workshop has helped me greatly. At first, I was not sure about my ability to major as an engineer because my math background was not that strong. But after MEW, it's like a new horizon has opened to me. Now my mind thinks on a more reasonable and logical level. I have gained a lot of confidence in my math ability since I attended MEW. I am ready to take on Chemical Engineering. ... I would like to thank Westinghouse ... the Workshop and this course have put tremendous confidence in me."

"This workshop has helped me by teaching me the type of studying I will need to do in college and how to figure out problems through analytical methods instead of memorization.

"I would like to thank ... Westinghouse for investing in me and my new-found friends."

Less tangible but equally encouraging results have been observed by the student staff. The resident mentors report that the students gather in groups on their own initiative to study for tests. The resident tutor notes that often students come in small groups for homework help, and in the process of explaining the question to him themselves come up with the answer.

EVALUATION OF LONG-TERM EFFECTS

In order to determine whether the Math Excellence Workshop produces any long-term improvement in the performance of the participants, we compared their subsequent per- pheromones of the first year students in MTHSC 106 to that of a control group selected from PEER students matriculating in Fall 1989. The control group consisted of all Black engineering students who entered as freshmen, took MTHSC 105 in the fall semester, and then took MTHSC 106 the following term.

These selection criteria eliminated those 1989 students who failed MTHSC 105, since none of them took MTHSC 106 the following term. No MEW students failed MTHSC 105, but two of the original 23 decided to change majors and have not taken MTHSC 106. The results of the comparison are shown in Table I

The data in Table I indicate that the intensive study offered by the Math Excellence Workshop does affect subsequent performance in first-semester calculus.

A similar comparison will be made for the 1991 MEW students when the data becomes available.

TABLE I

NEEDS TITLE

Group	No. of Students	Grade Distribution					Average Grade
		A	B	C	D	F	
MEW students	21	24%	14%	33%	19%	10%	2.24
1989 students	40	2%	12%	23%	23%	40%	1.15