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AUTHOR Carman, Robert A.
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ABSTRACT

Low ability freshmen enrolled in a 1972 fall semester remedial mathematics course at Santa Barbara City College (California) were randomly divided into three groups: (1) a control group comprised of 62 students meeting for one hour per week in small subgroups to study programmed materials; (2) a classroom tutoring group comprised of 67 students meeting weekly in small subgroups, with class time divided between programmed materials and tutoring by trained, experienced tutors; and (3) a total tutoring group comprised of 61 students enrolled in weekly small group sessions like those for group two, but with all students receiving from one to five additional weekly hours of tutoring at other times. At the end of the semester, each student was interviewed using a structured interview technique. Neither course grades nor GPAs differed significantly among the three groups. However, significantly fewer students in the tutored groups withdrew from the course. In addition, the structured interviews showed that student attitudes in the tutored groups were significantly more positive toward both mathematics and all other courses. The pattern of increased persistence and positive attitude of the tutored group continued during the two years following tutoring. Data are organized into charts and tables, and a bibliography is appended. (NHM)

A LONG-TERM STUDY OF THE EFFORTS OF TUTORING IN DEVELOPMENTAL MATHEMATICS

ROBERT A. CARMAN
SANTA BARBARA CITY COLLEGE

For more than twenty centuries, possibly before the time of Plato, tutoring has been hypothesized to be superior to other instructional methods. Yet despite this venerable history, tutoring as an educational variable has been the subject of remarkably little formal study, due perhaps to the apparent impracticality of using tutors on any large scale basis. This scarcity of research on tutoring is especially marked in higher education.

The large majority of the research studies published on the effects of tutoring have been concerned with the elementary and secondary school level. In an attempt to discern patterns that would be helpful in the development of tutor training materials and guidelines for matching tutors to students, McClellan reviewed the literature on student tutoring and found that most of the studies available involved the tutoring of students at pre-college levels (49). This finding was substantiated by Thelen (84) and by Riessman (68) in similar reviews of tutoring activities and research.

Tutoring studies at the elementary-secondary school level have focused primarily on tutoring in reading and writing skills. Tutoring is mainly "cross-age" or "inter-grade" in nature, employing older children to tutor younger, low-ability children. There is substantial evidence that tutoring can produce significant improvement in achievement, especially if it is used to supplement conventional classroom work. The evidence that tutoring produces more positive attitudes and self-concepts in tutored children is contradictory and incomplete. The changes in achievement and attitude of tutors participating in tutoring programs are significantly positive. Very few long-range or longitudinal studies of the effects of tutoring at the elementary-secondary school level are reported in the research literature.

Tutoring in Colleges

There are two major varieties of compensatory education programs in higher education: (1) those that assist educationally disadvantaged or culturally different students to enter institutions of higher education and (2) those that help these students succeed in academic and occupational objectives once they have enrolled. Compensatory education entry practices include modified recruitment and modified financial aid programs. As Knoell pointed out, in both kinds of programs the purpose is to reach students who would not plan

normally to go on with their education (42:6). The second variety of compensatory education program includes activities designed to enable the educationally disadvantaged student to succeed in conventional instructional situations.

Morrison and Ferrante pointed out that:

> Compensatory programs are often developed with the assumption that the culturally different have academic abilities which are inadequate for the traditional college classroom. In order to assist these students in realizing their potential, some institutions have developed special tutorial programs to support classroom activities. These programs have provided extensive individual tutoring in academic areas, with some schools developing corps of tutors which include teachers, graduate students, regular undergraduate students, and advanced students from culturally different backgrounds. (61:8).

The Programs

In a study of fifty-three public and private two-year colleges conducted by the American Council on Education, it was found that 91 percent reported some kind of special tutoring program for academically disadvantaged students. More than three-fourths of these colleges used regular students as tutors in their tutorial programs (61:30). The use of tutors is increasing rapidly, especially in the two-year colleges (88).

Despite the widespread occurrence of these programs, studies of tutoring at the college level are very few. Tutoring studies have been reported in the areas of reading and writing skills (1, 8, 81, 86, 90, 92), study skills (25, 81), basic mathematics (90), engineering (10, 82, 83), psychology (35, 86), and in advanced courses (58). Tutors are used both as supplements to conventionally taught courses and as the exclusive means of instruction.

The Tutors

The tutors employed in college-level tutoring programs are usually either faculty members or regularly enrolled students. Williams reported that tutors drawn from the same socio-economic, ethnic, or racial background as the students being tutored are often employed in order to provide role models (88:196). Pierce and Norell found that black tutors were especially effective with black students in terms of the perceived accessibility of the tutors (67:171) although no differences were found in either achievement or attrition rates.

Reports regarding most college-level tutoring programs state that their major objectives are to provide (1) an increase in achievement in the tutored area, (2) improved study skills, (3) enhanced self-esteem, (4) more positive attitudes toward college, and (5) increased persistence in college. The available evidence on achievement gains has not been consistently positive. Sykes (81) studied the effects of tutoring, reading instruction, and financial assistance upon student achievement, attitudes, and attrition of community college students enrolled in a special program for "disadvantaged" students. Student achievement, as measured by grade-point average, was not significantly improved by the program. Attitudes and study habits as measured by a self-image concept survey (Brown-Holtzmon survey of Study Habits and Attitudes) showed no consistent pattern of change. Reading skills, as measured by the Diagnostic Reading Tests, improved significantly but appeared to have no effect on student achievement as measured by grade-point average. The study suggested that this program was somewhat effective in retaining college students who might otherwise not remain in school. Unfortunately, the study was not designed to isolate and control confounding variables so that the direct effect of tutoring on attrition might be determined.

The Results of Tutoring

Lucas, Gaither, and Montgomery (48) evaluated a tutorial program involving volunteer college freshmen subjects and a control group of non-attenders. Results indicated that tutoring was ineffective in raising grades. This study was confounded by the difficulty of deciding whether an appropriate control group would be non-volunteers or volunteers who dropped out of the program. Ewing and Gilbert (27) indicated that the act of volunteering for tutoring help can be a more important factor in academic improvement than the tutoring itself.

Evans (26) compared the grade-point averages for tutored and non-tutored Extended Opportunity Programs and Services (EOPS) students. Tutored EOPS students earned a grade-point average of 2.54 on a scale with maximum of 4, while non-tutored EOPS students earned a grade-point average of 2.37. No significant positive effect of tutoring alone could be determined from the study (26:54)

In a similar evaluation of Extended Opportunity ervices MacMillan (51) failed to show any significant difference in achievement as measured by increased grade-point averages. Wright (90) examined the performance of almost 800 college freshmen who were predicted to perform unsuccessfully on the basis of entrance testing and who received tutoring by upper-division students in English, mathematics, social science and science. Results indicated that tutoring was an effective

means for raising achievement levels for many students. Students predicted lowest in achievement appeared to profit least from tutoring or did not take advantage of it. Those predicted in the average range appeared to profit most from tutoring and participated most.

Taylor (82) examined the effects of a tutoring program on engineering freshmen. Thirty-one students participated in the program and were matched by grade-point average with a control group of non-tutored students. He found that students with a gradepoint average below 2.00 were able to make effective use of the tutorial program to obtain significantly higher grades. Furthermore, the term by term academic trend of both groups suggested that the tutored students progresses steadily upward over the year-long study while the control group followed a downward trend.

Etters studied the effectiveness of a college tutorial program employing full-time bachelor's degree level tutors. It was found that tutored low achievers carrying less than a full course load were more successful in raising their grade-point average than any other category of students (25:406).

While the evidence for the effectiveness of tutoring in improving the academic achievement of college students is often ambiguous or negative, the evidence for its effectiveness in reducing attrition is very positive. Adams (1) in an informal study of tutoring in a community college reading program, found very positive evidence that tutoring led to increased persistence in the program.

In contrast to an annual withdrawal rate of more than forty percent in conventionally taught sections of the course, tutored groups had no withdrawals during a year-long study.

This finding of decreased withdrawal rates under tutoring was consistent with evaluations of other personalized systems of instruction. Born and Hebert (10) found decreased withdrawal rates and increased attendance under a scheme of instruction in psychology in which students progressed at their own rate through the course with the assistance of tutors or proctors.

In MacMillan's study of Educational Opportunity students, 85 percent of those tutored persisted in college, compared with a college-wide average of 74 percent (51). Sykes (81) in his study of similar low-ability students found that tutoring had a significant positive effect on the persistence of students in the program.

In Taylor's study of tutored engineering freshmen, a

significantly lower percentage of tutored students than of control group students withdrew during the first year (83:91). Students in both the experimental and control groups were exceptionally able students, in sharp contrast to those studied by Sykes (81) and MacMillan (51). In another program for more able students, Tillett, Porter, and Joiner (86) employed peer tutoring in biology, physics, psychology and social science classes. Withdrawal rates in the tutored classes were significantly lower than in non-tutored classes held the previous year while the fraction of "A" and "B" grades did not change significantly.

In a study of open enrollment students, Yuthas (92) matched groups on high school grade-point average, sex, and American College Testing entrance examination scores. The groups receiving tutoring in reading showed significant improvement on the Nelson-Denny Reading Test. Comparison of persistence rates for the experimental and control groups indicated a highly significant decrease in the withdrawal rate of tutored students. Enrollment in the tutoring program was significantly related to persistence in college and to resistance to extraneous influences which normally lead to withdrawal (92:234). As in most other studies, however, it was impossible to separate the influence of tutoring per se from the other instructional activities involved in the tutoring program.

Although longitudinal studies of the effects of tutoring college students have been recommended by Benz (8:12) and Sykes (81:55), extensive review of the published literature reveals no long-term studies. The lack of such studies is particularly unfortunate in the light of widespread fears at the college level and evidence at the secondary level that tutors tend to "teach to the test" and trade short-term gains in course gains or test scores for deeper understanding (65:414).

In one significant and suggestive long-range study not involving tutors, Caither found that persistence and performance over a four-semester period were not significantly related to enrollment in remedial programs. Using a control group of students not enrolled in a remedial program but matched with the experimental group on the basis of preliminary academic aptitude scores, Gaither found that,

> the academic (control) group outperformed the remedial group in every semester except the first semester when the remedial group had the 'shelter' of being in the remedial program and receiving grades commensurate with that special level (29:10).

Gaither found no difference in the two groups with respect to

attrition rate over the two-year span.

Gaither's study is especially significant for the study reported in this dissertation because it is one of the few longitudinal studies of developmental programs at the community college level and because it does not include tutoring as a variable.

An important assumption underlying the design of developmental programs at the college level is that they must provide the necessary ingredient to assure reduced withdrawal rates, improved academic performance, and more positive attitudes toward college. It is the bias of many instructional designers that peer tutoring is a vital ingredient in these developmental programs and that the negative findings of Gaither's study are a direct result of the lack of tutoring in the programs he examined. All of the studies of tutoring described test the effectiveness of tutoring over the time span of a single semester or college course. The present study is designed to examine the effectiveness of tutoring over a two-year period, a substantial portion of the college career for the students studied.

Low-Ability Students in the Community College

A number of studies provide a profile of the educationally disadvantaged student in the community college, and the picture indicates the importance of the present study. Roueche (73) estimated that more than seventy percent of all community college students need remedial assistance, reading scores at the fourth-grade level are common (24), withdrawal rates are typically over sixty percent (72).

In view of the number of students in this category and the severity of their problems, it is not surprising that the most offered courses in most community colleges are remedial or developmental in nature. Roueche estimated that more than twenty percent of the average total instructional budget is allocated to remedial programs (74). According to Morrison and Ferrante, specialized course and programs for the educationally disadvantaged have been developed and are rapidly increasing in number, scope, and size (61:23), and many educators actively encourage their development. Remedial reading and remedial mathematics courses are the most frequently found remedial courses in the community college (6,55).

In a 1963 study, Schenz (75:63) estimated that more than two-thirds of all community colleges automatically require low-ability students to enroll in remedial classes, yet most of these programs are based on faith rather than research. The evidence for the evidence for the effectiveness of

developmental programs in the community college is contradictory and incomplete. Gaither found no net positive effect of remedial programs in improving reading and writing skills or in reducing withdrawal rates (29). Sharon (77) studied the effectiveness of remedial programs and found that the English remedial course produced only a small improvement in subsequent performance in the regular English course. Conversely, the remedial course in mathematics had a significant positive effect on subsequent course work in mathematics, improving the average course grade by more than half of a letter grade. Losak (47) found that community college remedial programs in English and mathematics produce no significant difference in number of withdrawals and no significant increase in grade point averages. Roueche (73) found this lack of effectiveness of remedial courses to be widespread. In many communities up to 80 percent of entering freshmen enroll in remedial courses in mathematics and English, and only 20 percent of these continue into regular college level mathematics and English courses.

In a follow-up survey of students enrolled in several Chicago-area community colleges, Baehr (4) found that personalized remedial work significantly increased the student's expressed desire to persist in college. Heinkel (36) compared 122 students in a developmental program with a control group of 128 students enrolled in other programs. Males and ethnic minority students enrolled in the program withdrew from fewer courses in the first semester than did minority students in the control group.

Administrators of most community colleges assume that their remedial programs will result in long-term improvements in academic skills, attitudes, and performance of the educationally disadvantaged students for whom they are designed. However, the few research studies designed to test these assumptions were based on a short-term, one semester follow-up of students enrolled. Clearly, success in college is related to the ability of the student to persist in college over a period of time long enough for the desired changes to take place. Therefore, studies of the effectiveness of these programs in producing long-range changes in persistence and performance are needed.

Although most educators agree on the importance of improving the self-concept for the educationally disadvantaged student, very few studies of remedial programs have examined this variable. McDavid's work (50) indicated that academic success may result in a more positive self-image and lead to increased future academic success. Wessman (87) found a significant increase in self-acceptance as measured by the Cottell Personality Inventory in students completing an eight-week summer remedial program. Zirkel found that the self-concept

is significantly related to academic achievement for both disadvantaged and normal students (93:211). The enhancement of self-concepts is a goal of virtually all programs for educationally disadvantaged students.

The effects of negative self-image are particularly important in mathematics courses. Aiken found that mathematics instruction is more commonly the target of negative attitudes than other academic subjects such as reading and writing (2:558). These negative attitudes can influence the students expectation of future performance and affect his actual performance. Negative attitudes usually generate anxiety and hostility toward the subject. Attitudes toward mathematics and toward the self are strongly related to performance in mathematics classes (3:23).

A study of the available research literature suggests that the contradictory nature of the few research studies of remedial programs in the community college may be resolved if we analyze the programs in terms of the extent to which they were personalized, that is the extent to which they were designed to accommodate to individual differences. It is a reasonable conjecture that the unsuccessful remedial programs may have failed because of their lack of emphasis on factors which tend to personalize the program. It is these factors that may produce long-term self-image enhancement. One of the most effective personalizing elements used in remedial programs is tutoring.

Existing studies of educationally disadvantaged students in the community college and the remedial programs designed for them lead to the following assumptions:

1. Self-concept is significantly related to long-term achievement and persistence for disadvantaged students,
2. Self-concept enhancement tends to occur in personalized remedial programs,
3. Tutoring is an effective means of personalizing remedial programs,

and therefore,

4. Remedial programs in which tutoring plays an integral part should be effective in producing long-term improvement in academic achievement and persistence of educationally disadvantaged students.

This assumption underlies the hypotheses being tested in this study.

Developmental Mathematics in the Community College

The phrase "developmental mathematics" is most often used to indicate courses in arithmetic and elementary algebra that are usually encountered by most students in the elementary and secondary schools. In a 1966 survey of 73 California community colleges, Kipps (40) found that 59 colleges offered these developmental courses. In a later survey, Beal (6) examined developmental mathematics courses in 185 community colleges and found that only 42 respondents specifically indicated that they offered no such programs and six questioned the appropriateness of such mathematics courses. In 51 of the colleges offering developmental mathematics courses at least twenty percent of all mathematics students and more than one-half of the faculty were involved in these programs. Fifty percent of the colleges surveyed required students to enroll in a developmental course if their scores on standardized tests, previous grades in mathematics, or counselor recommendations indicated that they would profit from it. The most frequently indicated reasons for the existence of developmental mathematics courses were to enable students to continue in regular mathematics courses (85%) or to satisfy prerequisites for other non-mathematics courses.

In summary, tutorial programs for low-ability students are increasing in number and importance in the community colleges. Existing published studies of the effectiveness of tutorial programs are restricted to examination of their short-term results. Evidence of the effectiveness of these programs in producing significant positive changes in achievement, grades, or subsequent performance in regular college courses is contradictory. Most research studies agree that tutorial programs are effective in reducing attrition of students enrolled in the program. The contradictory nature of the available research may be resolved by analyzing the programs in terms of the extent to which they emphasize factors that tend to personalize instruction.

The basic intent of the present study was to examine the effect of tutoring on low ability community college students. All subjects in this experiment were students at Santa Barbara City College enrolled in the 1972 fall semester in a remedial mathematics course in basic arithmetic skills. Students entered this course by referral of counselors or teachers on the basis of low scores on the Scholastic Aptitude Test or inadquate performance in mathematics in previous courses. All students scoring below the 30th percentile on the Scholastic Aptitude Test were required to enroll in this course. Many students enrolled in this course were also enrolled in remedial courses in English and study skills, and in high school equivalent courses in the social sciences. A majority

of the students attending the college under programs for the educationally disadvantaged were among the nearly 1500 students enrolled in this course.

Sampling

The target population for the study was restricted to those enrolled in the course described above. Sampling from this population resulted in the formation of three experimental groups.

Group 1. Students in this control group met for one hour per week in small subgroups to study programmed materials. The meetings were supervised by a trained student tutor. Students took the four course examinations when they wished and were allowed to retake the examinations, using alternate forms until they received a score of 80 percent or higher. No tutoring took place in the weekly meetings attended by these students. Students who asked questions in the small group meetings were referred to explanations available in the programmed textbook. A total of 62 students were in group 1.

Group 2. Students in this classroom tutoring group were enrolled in weekly small group sessions exactly the same as those for group 1 except that class time was devoted to a combination of work in the programmed textbook and tutoring. Trained, experienced tutors, in a ratio of approximately one tutor for every five students, worked with the students providing additional explanation, encouragement, and general assistance. A total of 67 students were in group 2.

Group 3. Students in this total tutoring group were enrolled in weekly small group sessions exactly the same as those for group 2 except that all students received additional tutoring at times other than the required class meetings. Each student received a minimum of one hour per week of additional tutoring and a possible maximum of five hours of additional tutoring. A total of 61 students were in group 3.

The three experimental groups were formed by randomly assigning six mathematics laboratory sections to each experimental category. The resulting three experimental groups each consisted of six mathematics laboratory sections containing a total of approximately 60 full-time first-year students. No outward identification of groups was made and students were unaware that they had been assigned to mathematics laboratory sections in any systematic way.

In order to assure identical treatment of all mathematics laboratory sections included in group 1, the non-tutored control group, all sections were under the direction of the

same tutor. This tutor was aware of the nature and design of the study and had been carefully instructed as to the proper noncommittal responses to be made in response to student requests for information and assistance.

Ethical considerations required that tutoring assistance could not be withheld from students requesting it. The policy followed was that any student in the control group who requested tutoring would be allowed to transfer to another group not in the study and would be dropped from consideration in the study. No students in this group requested either tutoring or transfer from the group.

Several steps were taken to assure that there was no systematic difference between experimental groups at the outset that might influence the final result. First, random assignment of students to mathematics laboratory sections and of laboratory sections to experimental groups assured that every first-year full-time student had an essentially equal chance of being assigned to each of the experimental treatments. Random assignment to experimental groups allowed the use of simple statistical procedures for determining the significance of any observed differences in academic performance or subjective responses.

Second, only full-time students were included in the study. This restriction was a direct attempt to equate students on their commitment to their college program and the time available for academic work.

Third, only first-year students were included in the study in order to eliminate any possibility of past exposure to tutoring and to assure that members of the control group were unaware of the tutoring taking place in other sections of the course. Restriction of the experimental groups to first-year students also eliminated differences due to previous exposure to college work.

Both experience and a survey of the research literature indicated that differences in response to tutoring might be correlated with confounding variables such as sex, age, ethnic background, scholastic aptitude, socioeconomic background, previous training in mathematics, amount of time spent on outside employment, financial aid received, attitudes, and self-concept. It was assumed that randomization equalized these factors and eliminated any significant contribution they might make to differences in performance between groups. This assumption was tested for the variables of age, sex, scholastic aptitude, ethnic background, hours of outside employment, and amount of financial aid, in an attempt to determine if the experimental groups differed significantly on these variables.

Differences in the ability of tutors to effect significant changes in student performance was controlled by training tutors prior to the study and by meeting regularly with tutors in an attempt to maintain constant standards of tutor performance. All tutoring was performed within the framework set by the programmed instruction materials and the organization of the course. This tended to insure that all students received the same kind of tutoring assistance.

The primary experimental variables examined in this longitudinal study were grades in the developmental mathematics course, grades in subsequent mathematics courses, overall grade-point averages in subsequent semesters, withdrawal from individual courses and from college, and reenrollment in college after withdrawal. These objective, quantifiable variables were recorded during each semester for the two years following the initial enrollment. Students were followed through two years of their college career by means of records maintained in the Department of Admissions and Records of the college.

Because positive attitude change was expected by many instructors to be a major result of tutoring, an attempt was made to measure these changes directly over the course of the first semester. At the end of the 1972 fall semester each student was interviewed individually using a structured interview technique in which the questions asked were carefully planned beforehand. The interview technique was used in preference to a written questionnaire because many of the students enrolled in the developmental mathematics course were poor readers. Although interviewing was more time-consuming, it assured a meaningful response from every student.

The questions used in the interview were developed with the cooperation of staff members and tutors participating in the study. All 190 students in the three experimental groups were interviewed using the revised question list. Students who completed the course were interviewed immediately after completing the final required examination. Students who did not complete the course but who persisted throughout the semester were interviewed at the last mathematics laboratory section meeting. Students withdrawing from the course were interviewed when they requested permission to withdraw. In a few cases students withdrew without notifying the instructor, and these students were interviewed by telephone if they could not be reached for a personal interview.

To assure that equivalent instructional situations existed for each group, each mathematics laboratory section was visited briefly by the experimenter each week during the semester. Tutors met with the experimenter each week in a group training session in which any problems relating to tutoring in the experimental groups were discussed. Extensive efforts were made to assure that all mathematics laboratory

sections in a given experimental group were treated exactly alike. Tutored groups received no special tutoring beyond that normall given in non-experimental groups except that each subject in group 3 received additional tutoring time.

Students were assigned to the three experimental groups on an essentially random basis, and it was assumed that the groups did not differ significantly at the start of the investigation. Study of the research lieteature and experience in teaching developmental arithmetic at the community college level suggested that the initial variables most likely to influence student performance were sex, age, ethnic and racial background, Scholastic Aptitude (Quantitative) Test scores, receipt of financial aid, and number of hours of outside employment per week. It was assumed that the random assignment of subjects to experimental groups would eliminate any relative differences in performance due to these confounding variables.

Comparison of the experimental groups indicated that initially they were not significantly different in distribution of subjects by sex, age, ethnic and racial background, Quantitative Scholastic Aptitude test score, fraction receiving financial aid, or amount of outside employment. The purpose of the differential treatment applied to the three experimental groups was to deny tutoring in developmental mathematics to subjects in the control group and to assure a significantly larger amount of tutoring to the total tutoring group than to the classroom tutoring group.

The amount of tutoring received was determined by two independent methods: estimates by the tutors involved and estimates by the students being tutored. Both groups indicated that students in experimental group 1, the control group, received no tutoring. Comparison of tutor estimates of the amount of tutoring received by groups 2 and 3 is shown in Figure 1. There was unanimous agreement that students in group 2 received one hour per week of tutoring. The amount of tutoring received by students in group 3, as estimated by the tutors, varied as shown in Figure 1 with a mean value of 3.39 hours per week.

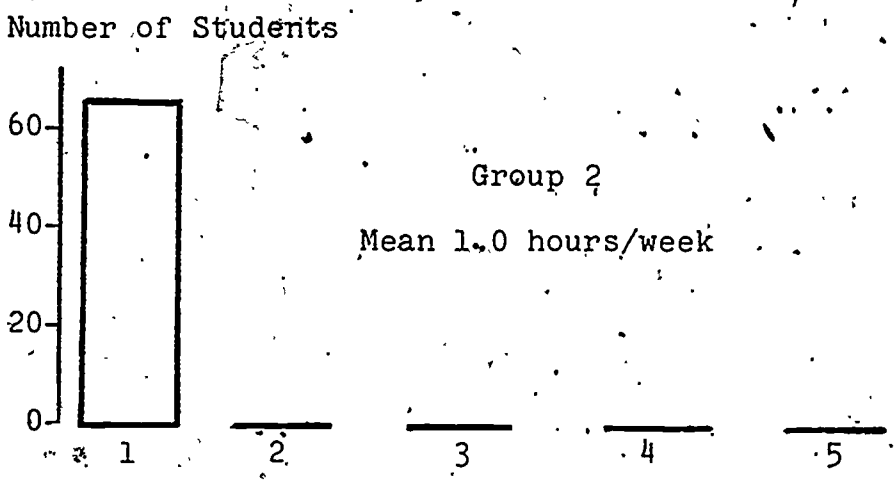
On the personal interview, students who had been tutored were asked to estimate to the nearest hour the average amount of tutoring they received each week. The distribution of responses for groups 2 and 3 is shown in Figure 2. The mean calculated for grup 3 was 3.89 hours per week. These estimates are in close agreement with the estimates bytutors.

The slight variation in estimates of tutoring time is a reflection of the fact that many students regard at least

FIGURE 1

AMOUNT OF TUTORING

AS ESTIMATED BY TUTORS



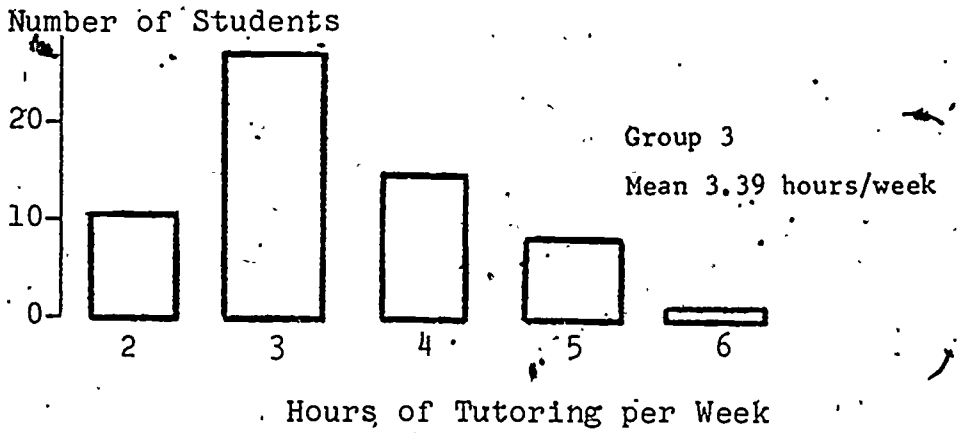
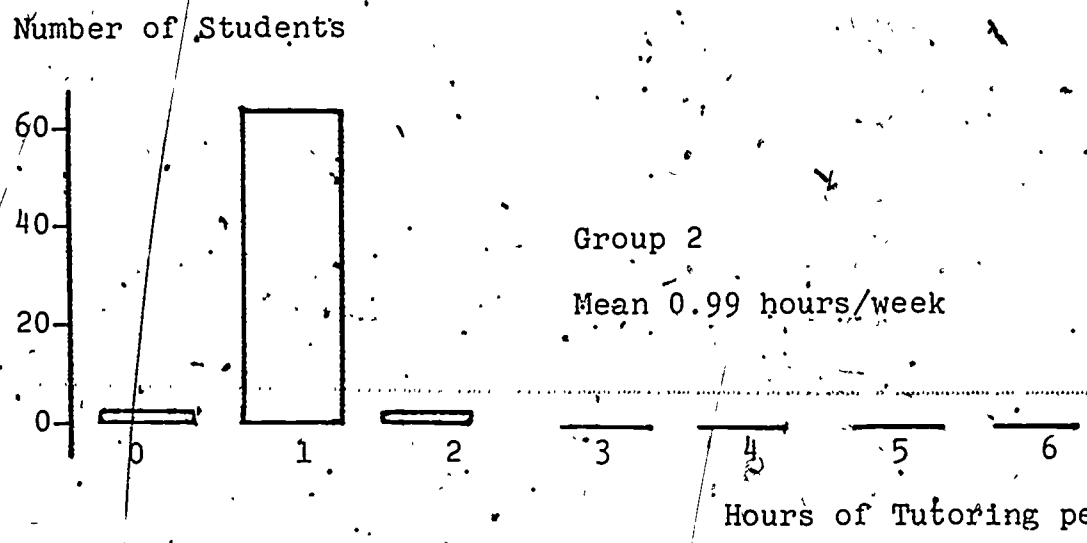
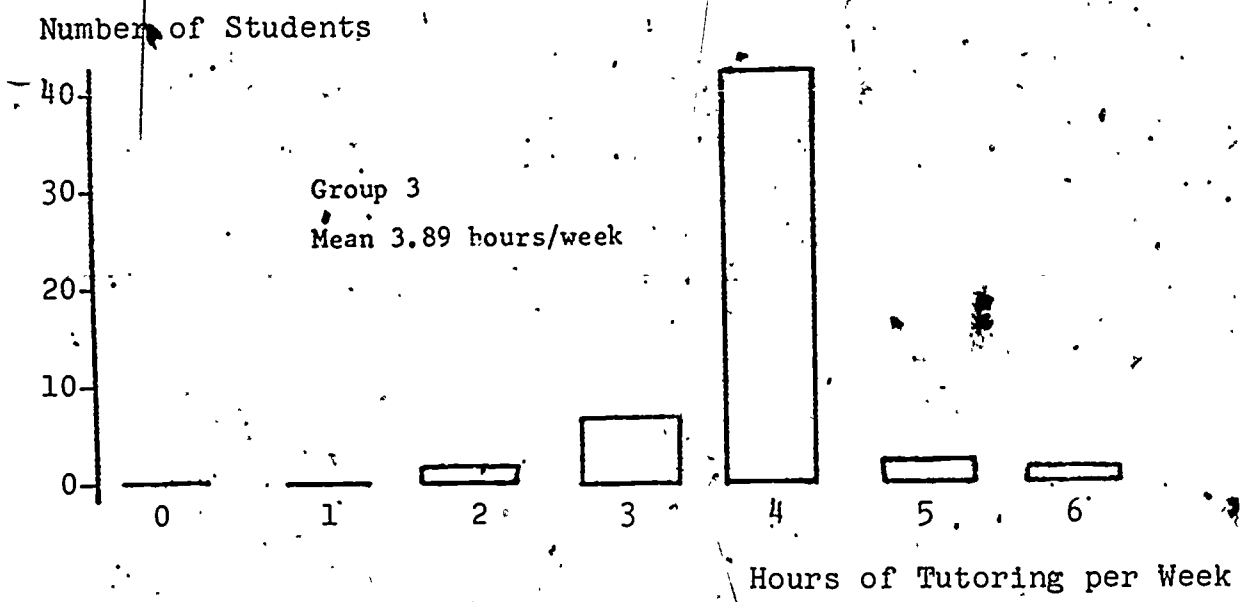


FIGURE 2

AMOUNT OF TUTORING

AS ESTIMATED BY STUDENTS





a portion of their personal contact with tutors as informal conversation rather than tutoring. Tutors regard the same activity as an attempt to build the rapport needed to do an effective job of tutoring.

Short-term Performance of Experimental Groups

The two most important measures of short-term performance for students in the experimental and control groups are academic grades, both in the developmental mathematics course and in other courses in which they were enrolled in the first semester, and persistence in their courses and in the college.

Academic Grades Figure 3 shows the distribution of grades within the three experimental groups for those students who completed the developmental mathematics course during the first semester. Grade averages were calculated on the usual basis of assigning 4 points for an A grade, 3 points for a B grade, and 2 points for a C grade. As dictated by course policy, only A, B, and C grades were awarded to students completing the course successfully. A grade of C represented a score of at least 80% on each of the four course examinations. Students not completing all four examinations at the 80% level or higher received no letter grade. Statistical analysis indicates that the grade distributions are not significantly different.

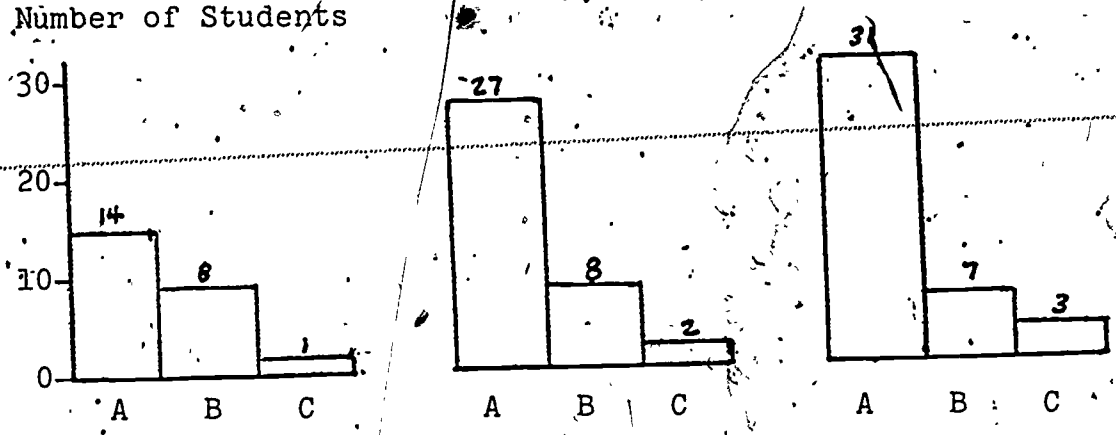
A second measure of short-term academic performance is the first semester grade-point average for courses other than developmental mathematics. A summary of these grades appears in Figure 4. Statistical analysis indicates that the three groups did not differ significantly with respect to the grades received in courses other than developmental mathematics.

Persistence The fact that grades in both the developmental mathematics course and in other courses taken during the first semester are not significantly different for the tutored and non-tutored groups may seem surprising and may appear to be a denial of the efficacy of tutoring as an instructional process. However, closes examination of Figures 3 and 4 reveals that additional analysis is necessary.

Figure 5 is a summary of the developmental mathematics course results for all students enrolled. The number of developmental mathematics students withdrawing from the college or not completing the developmental mathematics course during this semester is less for the tutored groups than in the non tutored control group. If the mean grade-point average is calculated for all groups by assigning a value of zero for a withdrawal grade, then the average grade for the tutored groups is larger than the averge grade for the controls.

FIGURE 3

GRADES IN DEVELOPMENTAL MATHEMATICS



Mean Grade 3.57	Mean Grade 3.68	Mean Grade 3.66
N = 23	N = 37	N = 41
Group 1	Group 2	Group 3
No Tutoring	One hour per week of tutoring	3.5 hours per week of tutoring

FIGURE 4

GRADE POINT AVERAGES

FOR DEVELOPMENTAL MATHEMATICS STUDENTS

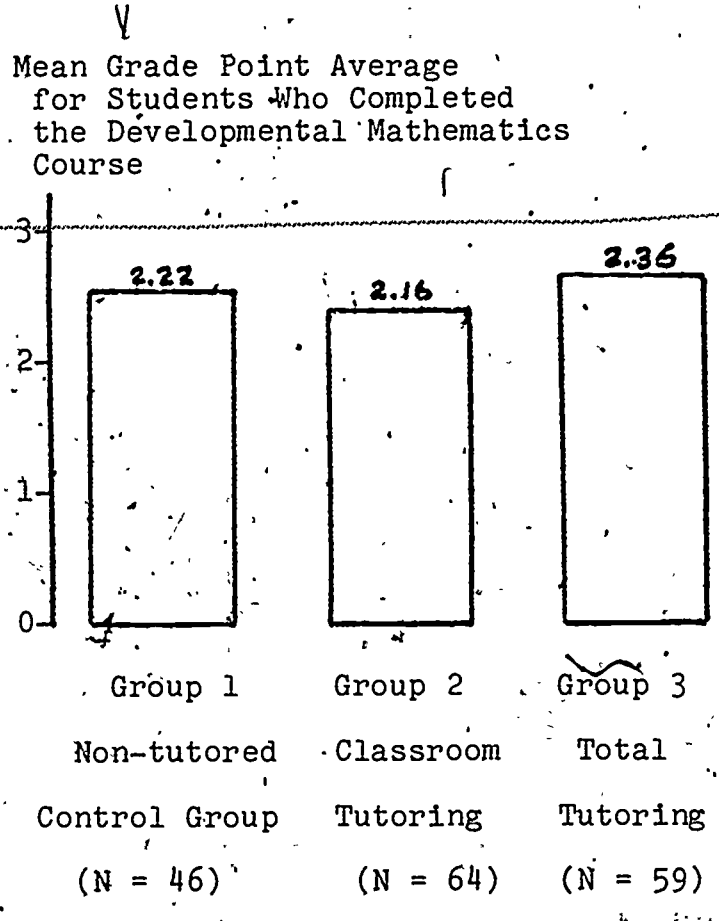


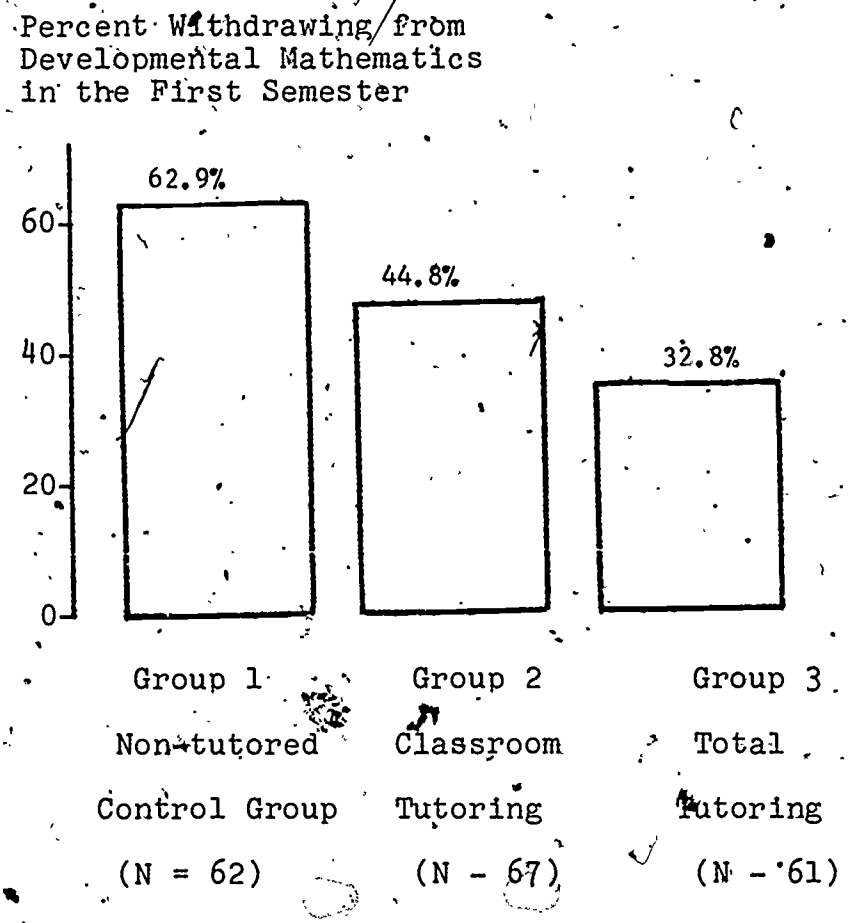
FIGURE 5

Grades for Students Enrolled in Developmental Mathematics in the First Semester

	Group 1 Non-tutored Control Group	Group 2 Classroom Tutoring	Group 3 Total Tutoring
Number initially enrolled	62	67	61
Number receiving a passing grade in the first semester	23	37	41
Number withdrawing from college in the first semester	16	3	2
Number no completing the course in the first semester	23	27	18
Average grade received (A=4, B=3, 0=2)	3.57	3.68	3.66
Modified Grade Average (A=4, B-3, C=2, W=0)	1.32	2.03	2.46

FIGURE 6

STUDENTS WITHDRAWING FROM DEVELOPMENTAL MATHEMATICS



The results of an analysis of variance performed on these data indicates that when the grades of students withdrawing from the developmental methematics course are included in the analysis, the tutored groups earned significantly higher grades than did the non-tutored controls.

From this analysis it is clear that the developmental mathematics course policy of allowing all students to withdraw from the course if they do not complete the required examinations, and of assigning only A, B, and C grades, modifies the grade distribution obtained. More students withdrew from the control group than from the tutored groups, resulting in a spuriously high mean grade-point average for the control group relative to the tutored groups. According to Figure 5 the relative persistence of tutored versus non-tutored students is an important variable.

Figure 6 is a comparison of the relative numbers of students withdrawing from each of the three experimental groups. Substantially fewer students withdrew from groups 2 and 3, the tutored groups, than from group 1, the non-tutored control group. The 62.9% withdrawal rate from the developmental mathematics course for group 1 is consistent with information on the withdrawal rate of 50% to 70% in this course before tutors were employed. The 44.8% withdrawal rate for group 2 is consistent with a withdrawal rate of 40% to 45% in previous semesters when tutors were employed in a classroom tutoring situation, according to informal records maintained by the college.

Statistical analysis of this information indicates that these differences in the experimental groups are significant at beyonde 0.01 level. There is a significant difference in the withdrawal rates for the three groups, with more students in the non-tutored control group withdrawing than in either of the tutored groups.

This pattern of withdrawal is even more pronounced if the frequency of withdrawal of remedial mathematics students from the college is examined. Figure 7 shows the percent of students enrolled in remedial mathematics who withdrew from college entirely during the first semester. The percent of students withdrawing from the non-tutored group (25.8%) is more than six times the percent of students withdrawing from the combined tutored grups. (3.9%).

Additional evidence supporting the effect of tutoring on student persistence outside of the specific class being tutored is found in Figure 8. Figure 8 indicates that the percent of developmental mathematics students withdrawing from any course in the first semester is higher for the non-tutored control group (75.8%) than for either the classroom tutoring group (56.7%) or the total tutoring group (49.2%). These differences are statistically significant.

These findings agree with the research reported by Evans

(26), Lucas, Faither, and Montgomery (48), Macmillan (51), Mohan (59), and Riessman (68) indicating that tutoring has little direct effect on course grades.

These findings also support the observations of Adams (1), Born and Hebert (10), Etters (25), Sykes (81), Taylor (83), Tillett, Porter, and Joiner (86), and Yuthas (92) that tutoring is very effective in reducing attrition. A major short-term effect of tutoring appears to be the development of psychological changes in students that influence their behavior outside the specific area of tutoring. In particular, for this study, although the tutored and non-tutored groups did not differ significantly in the grades earned in either the tutored course or in other courses, they did differ significantly in the rate at which they withdrew from the tutored course, from other courses, and from the college during the first semester.

FIGURE 7.

STUDENTS WITHDRAWING FROM

COLLEGE IN THE FIRST SEMESTER

Percent of Developmental Mathematics Students Withdrawing from College in the First Semester

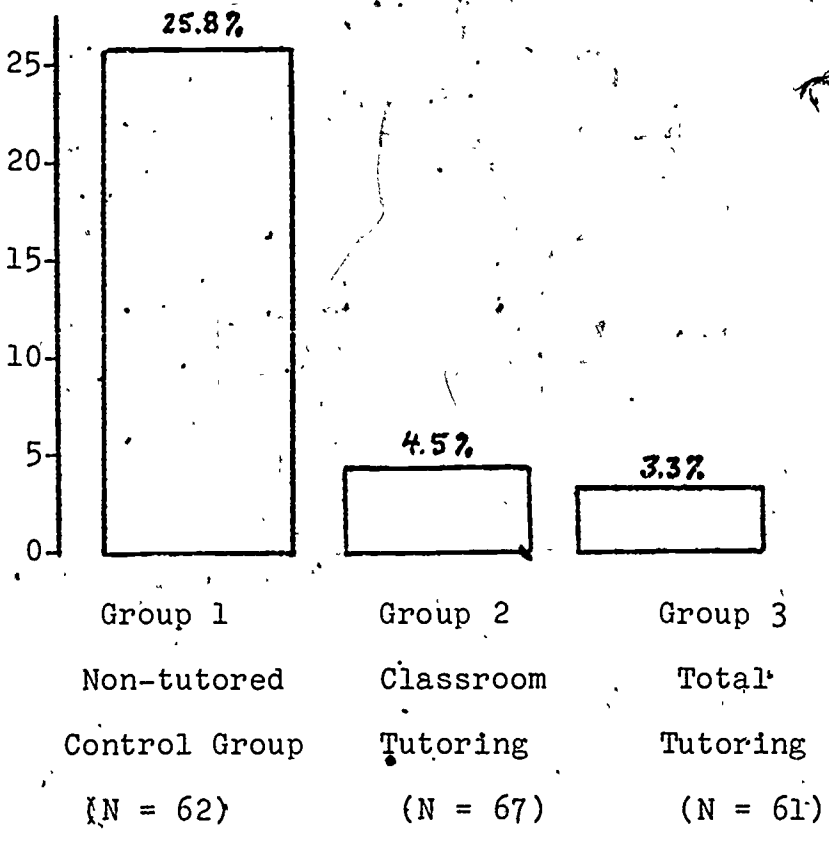
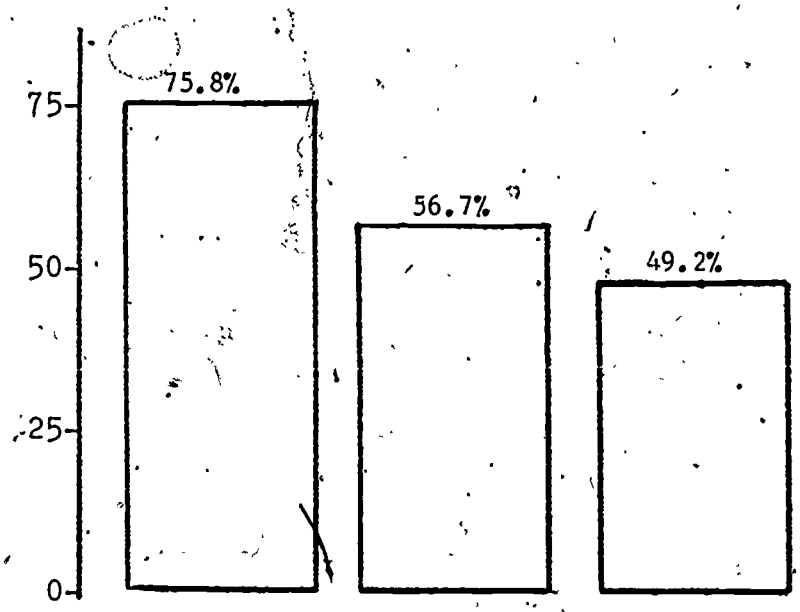


FIGURE 8

STUDENTS WITHDRAWING FROM

COURSES IN THE FIRST SEMESTER

Percent of Developmental Mathematics Students Withdrawing from Any Course in the First Semester



Group 1	Group 2	Group 3
Non-tutored Control Group	Classroom Tutoring	Total Tutoring
(N = 62)	(N = 67)	(N = 61)

Long-term Performance of Experimental Groups

If the short-term psychological changes apparently produced by tutoring persist beyond the semester in which the tutoring takes place, and if these changes are sufficiently general as to affect student performance in areas other than the tutored area, then their differential effects can be expected to appear in the long-term academic performance and persistence of the experimental groups.

Academic Grades The primary reason for using tutoring in the developmental methematics course was to increase the probability that a student would complete the course successfully. Figure 9 is a summary of the performance of all students enrolled in developmental mathematics course during the first semester of the study.

For group 1, of the 39 students who did not complete the course in the first semester, 9 withdrew from the college and did not return. Of the remaining 30, 22 completed the course during the four semesters of the study. A total of 45 or 72.6% of the non-tutored control group (group 1) completed the course successfully.

For group 2, of the 30 students who did not complete the course in the first semester, two withdrew from the college and did not return. Of the remaining 28, 20 completed the course during the four semesters of the study. A total of 57 or 85.1% of the classroom tutored group (group 2) completed the course successfully.

For group 3, of the 20 students who did not complete the course in the first semester, one withdrew from the college and did not return. Of the remaining 19, 13 completed the course during the four semesters of the study. A total of 54 or 88.5% of the total tutoring group (group 3) completed the course successfully. Figure 10 is a graphic presentation of this information.

Statistical analysis indicates that the different in the relative numbers of students completing the developmental mathematics course for the three experimental groups is significant at the 0.05 level. Significantly more of the students in the tutored groups completed the developmental mathematics course in the four semesters of the study than did students in the non-tutored control group.

One function of the developmental mathematics course is to prepare students to continue their studies in a subsequent algebra course. Of the 37 students in group 1 who successfully completed the developmental mathematics course in the first semester and who reenrolled in the college in the second

FIGURE 9

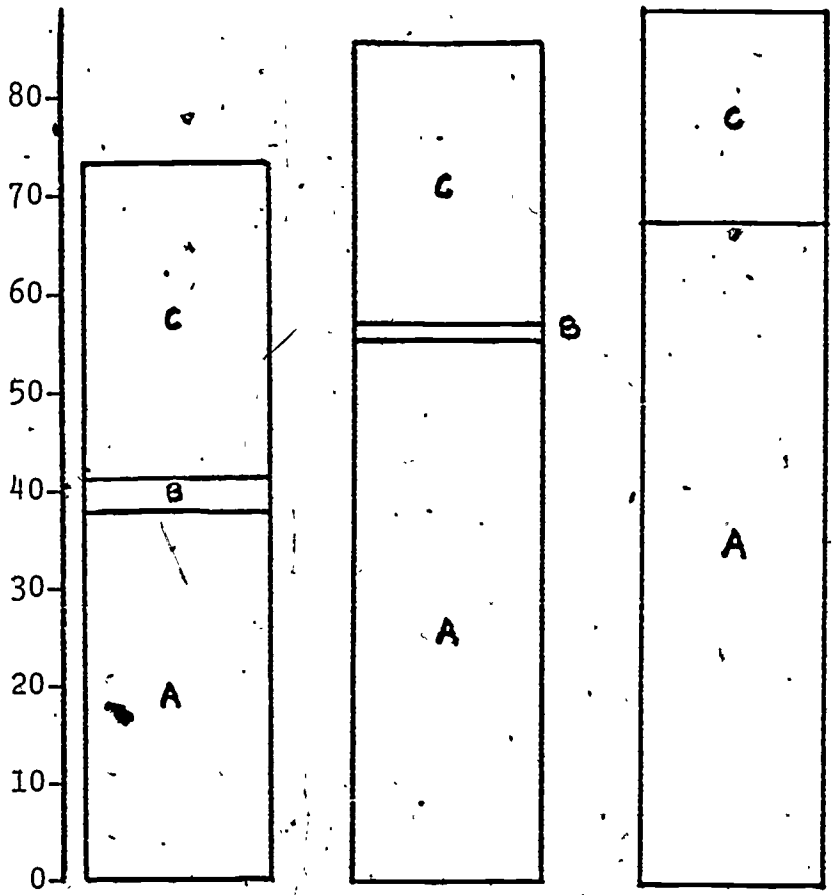
LONG-TERM PERFORMANCE OF DEVELOPMENTAL MATHEMATICS STUDENTS

	Group 1		Group 2		Group 3	
	N	Percent	N	Percent	N	Percent
Initially enrolled	62	100	67	100	61	100
Completed first semester	23	37.1	37	55.2	41	67.2
Withdrew from college	16	25.8	3	4.5	2	3.3
Never returned	9	14.5	2	3.0	1	1.6
Returned to course in four semesters	4	6.5	1	1.5	0	0
Completed course in four semesters	2	3.2	0	0	0	0
Returned to course, did not complete it	2	3.2	0	0	1	1.6
Returned to college, did not reenroll in the course	3	4.8	0	0	0	0
Withdrew from the course	23	37.1	27	40.3	18	29.5
Completed course in second semester	5	8.1	11	16.4	8	13.1
Completed course in third semester	9	14.5	5	7.5	5	8.2
Completed course in fourth semester	6	9.7	3	4.5	0	0
Did not complete the course	3	4.8	8	11.9	5	8.2
Completed Developmental Mathematics course within four semesters	45	72.6	57	85.1	54	88.5

FIGURE 10

STUDENTS COMPLETING DEVELOPMENTAL MATHEMATICS

Percent Completing Developmental Mathematics
Within Four Semesters



A Percent completing the course in the first semester

B Withdrew from the college and returned to complete the course within the four semesters of the study.

C Continued in college and completed the course within the four semesters of the study.

semester, only 10, or 27.0%, over enrolled in a subsequent mathematics course. Of the 53 students in group 2 who successfully completed the developmental mathematics course in the first semester and who reenrolled in the college in the second semester, only 14, or 26.4%, ever enrolled in a subsequent mathematics course. Of the 56 students in group 3 who successfully completed the developmental mathematics course in the first semester and who reenrolled in the college in the second semester, only 11, or 19.6%, ever enrolled in a subsequent mathematics course. Statistically, there is no significant relation between the number of students enrolling in a subsequent mathematics course and the amount of tutoring received by them in developmental mathematics.

Average grades for all students enrolling in algebra after successful completion of developmental mathematics are shown in Figure 11. These grades are not significantly different.

When grade averages for students completing the second and third semesters are calculated by including withdrawal grades, there is a significant increase in grade average for the tutored groups with respect to the non-tutored control group. There is no significant difference in grade averages between the classroom tutoring and total tutoring groups.

Persistence If tutoring tends to promote significant psychological changes in the student leading to decreased attrition during the first semester, then it is reasonable to expect that these changes may lead to significantly altered patterns of attrition in subsequent semesters.

Three basic patterns of persistence are found in the experimental groups:

1. Students may withdraw from the developmental mathematics course and reenroll in a subsequent semester.

2. Students may withdraw from the college and reenroll in a subsequent semester.

3. Students may complete the developmental mathematics course in the first semester and reenroll in a subsequent semester.

With respect to the first of these patterns, it was found that there is no significant difference among experimental groups in the number of students who reenroll after withdrawing from the developmental mathematics course during the first semester. This finding is consistent with the observations of tutors and instructors associated with the developmental

FIGURE 11

Average Grades for Students Enrolling in an Algebra course After Successful Completion of Developmental Mathematics in the First Semester

	Group 1 Non-tutored Control Group	Group 2 Classroom Tutoring	Group 3 Total Tutoring
N	10	14	11
Grade Average[1]	1.40	1.57	1.73

[1]The grade average was calculated on the basis of A = 4, B = 3, C = 2, D = 0.

mathematics course that 70% to 80% of all students who withdraw from developmental mathematics will reenroll. Most of these students have completed some portion of the course and have a strong incentive to reenroll in order to earn a passing grade.

With respect to the second pattern, there is no significant difference among experimental groups in the number of students who reenroll after withdrawing from the college during the first semester. Although the relative frequency of withdrawal of students from college is significantly greater for the non-tutored students in the control group, the fraction of students reenrolling is independent of their previous experience with tutoring.

With respect to the third pattern, there is no significant difference among experimental groups in the number of students who reenroll in a subsequent semester after successful completion of the developmental mathematics course. This finding supports observations by tutors and instructors in the developmental mathematics course with respect to the very positive effect on student morale of successfully completing the developmental course.

There is a significant relation between the number of students enrolled in college in the fourth semester and the amount of tutoring received by them. While 38.7% of the students in the non-tutored control group (group 1) are enrolled in the college in the fourth semester, 86.7% of the tutored students (groups 2 and 3) are enrolled in the college in the fourth semester. This difference is significant at well beyond the 0.01 level. The number of tutored students enrolled in the college in the fourth semester is significantly greater than the number of non-tutored students enrolled in the fourth semester. This finding is consistent with the increase in short-term persistence. Tutored students are significantly more likely to persist in college than are their non-tutored counterparts.

If tutoring is associated with increased persistence in college, it might be expected that tutored students who enroll in a subsequent algebra course would be less likely to withdraw from that course than non-tutored students. However, the fraction of students withdrawing from algebra is essentially the same for all three experimental groups. Taken together the findings support the conclusion that the amount of tutoring received by students in developmental mathematics is not a significant factor in determining their subsequent enrollment, grades, or persistence in an algebra course. This result was not unexpected. The developmental mathematics course concepts are qualitatively different from those encountered in algebra. The developmental mathematics course emphasizes arithmetic

computation and practical problems rather then theoretical concepts and abstract problems. The skills required for success in the algebra course are not the same as those required in the developmental course; they are necessary for success in algebra but not sufficient.

If tutoring produces psychological changes associated with increased long-term persistence in college courses, it might be expected that students in the tutored groups would withdraw from subsequent courses less frequently than students in the non-tutored control group. In Figure 12 the percent of students withdrawing from one or more courses in the second semester is given for each of the three experimental groups. More than double the number of students from the non-tutored control group withdraw from one or more courses in the second semester than from either of the tutored groups. Again, tutoring is associated with long-term persistence in college courses.

Summary and Interpretation of Interview Results

On the basis of the personal interviews held with each student it was possible to assess their expressed attitudes toward developmental mathematics, toward other courses, and toward the college.

Figure 13 is a summary of the attitude toward mathematics ratings arranged according to experimental groups. As expected, the expressed attitudes of students in the tutored groups were more positive than the expressed attitudes of students in the non-tutored control group. The mean rating for tutored students fell in the neutral category. For most students enrolled in a developmental mathematics course the normal response to any question about attitudes toward mathematics or mathematics courses is strongly negative. Modifying that response from negative to neutral, as has apparently accomplished here, is a substantial achievement.

One question on the interview involved the change in the student's attitude toward other college courses over the semester. The responses are summarized in Figure 14. Students in the tutored groups indicated a significantly more positive change in attitude toward all courses than did students in the non-tutored control group. This finding is consistent with the significant decrease in withdrawal from courses in the first semester and the more positive attitude toward developmental mathematics found for students in the tutored group as compared to students in the non-tutored control group.

Responses to the interview questions by tutored students revealed that many of them were receiving assistance from the

FIGURE 12

STUDENTS WITHDRAWING IN THE SECOND SEMESTER

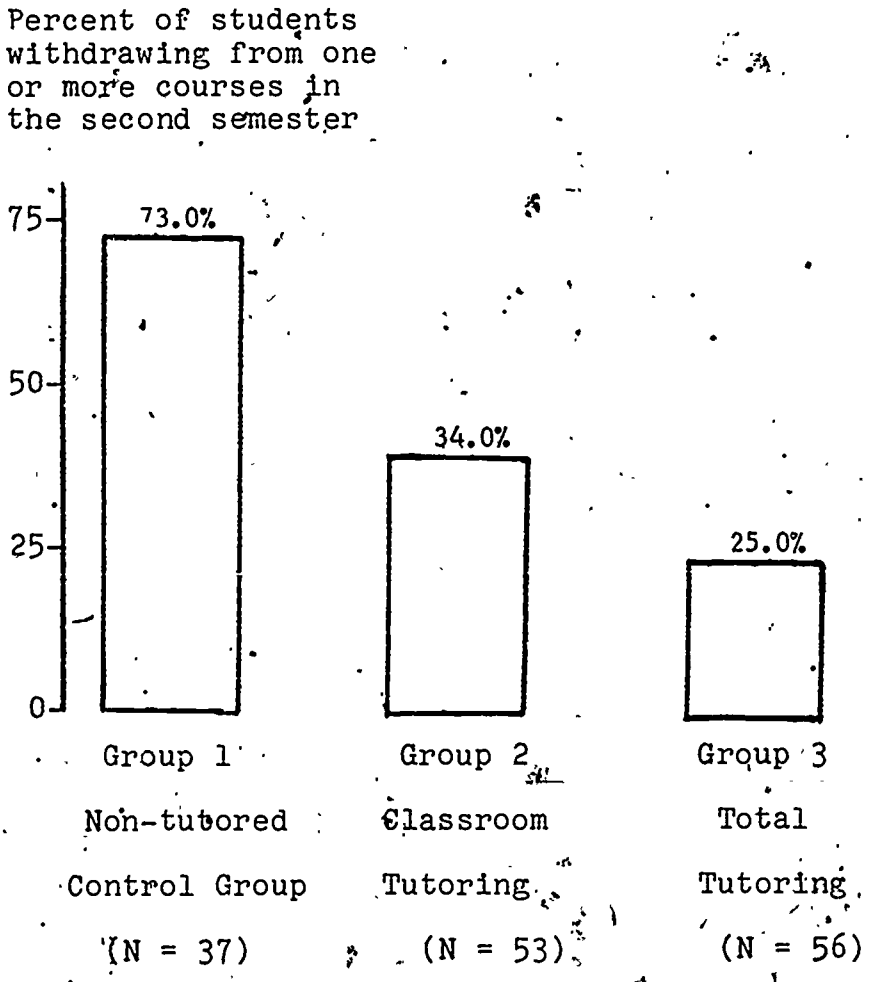


FIGURE 13

Composite Attitude Toward Mathematics
Rating Based on Responses to Interview
Questions

N	Mean Rating	Range
62	8.08	5 to 12
67	12.61	8 to 17
61	12.66	9 to 17

A rating of 10 or less represents a negative attitude toward mathematics.

A rating of 11 to 13 represents a neutral attitude toward mathematics.

A rating of 14 or more represents a positive attitude toward mathematics.

FIGURE 14

Responses to Question 9 in the Interview

Question 9: Has your attitude toward other college courses changed from what it was when you started the semester? If so, how?

	Group 1 Non-tutored Control Group (N = 62)	Group 2 Classroom Tutoring (N = 67)	Group 3 Total Tutoring (N = 61)
Response			
(a) I have a much more negative attitude	3	0	0
(b) I have a more negative attitude	21	0	0
(c) My attitude has not changed	38	15	0
(d) My attitude is more positive	0	37	33
(e) My attitude is much more positive	0	15	28
Mean Response using (a) = 1, (b) = 2, (c) = 3, (d) = 4, (e) = 5.	2.56	4.00	4.46

tutors with courses other than developmental mathematics. Many indicated that their attitude toward other courses was more positive because they were receiving this personal help and because they believed they could succeed in the other courses with this help. Responses to the interview questions by tutored students reflected open appreciation for the tutorial help they were receiving and a feeling that they could succeed in their college courses because of the tutorial help they were receiving. For many, the tutorial assistance was viewed as a direct effort by the college to help them succeed.

SUMMARY

The following are the findings related to the performance of the experimental groups during the first semester:

1. The tutored and non-tutored groups did not differ significantly with respect to the grades received in developmental mathematics during the first semester. Grade-point averages did not differ significantly among the three groups.

   If the grades of students withdrawing from the developmental mathematics course are included in the grade average, students in the tutored groups earned significantly higher grades than did students in the non-tutored control group. If grade-point averages are calculated by assigning a value of zero to a withdrawal grade, students in the classroom tutoring group, who received one hour of tutoring per week, had an average of 2.03. Students in the total tutoring group, who received approximately 3.5 hours of tutoring per week, had an average grade of 2.46. Students in the non-tutored control group had an average grade of 1.32.

2. Significantly fewer students withdrew from the tutored groups than from the non-tutored control group. Of the non-tutored students 62.9 percent withdrew from developmental mathematics in the first semester while 39.1 percent of the students in the tutored groups withdrew.

3. On the basis of the structured interviews, students in the tutored groups were rated as significantly more positive in attitude toward developmental mathematics than were students in the non-tutored control group. The average rating of attitude toward mathematics for students in the tutored groups fell in the neutral category while the average rating for students in the non-tutored group fell in the negative category.

4. The tutored and non-tutored groups did not differ significantly with respect to the average grades received by students in the first semester in courses other than developmental mathematics.

5. Significantly more of the students in the non-tutored control group withdrew from at least one class than in either of the tutored groups. Of the tutored students 53.1 percent withdrew from at least one course during the first semester, while 75.8 percent of the students in the non-tutored control group withdrew from at least one course.

6. On the basis of the structured interview responses, students in the tutored groups indicated a significantly more positive change in attitude toward all other courses than did students in the non-tutored control group.

The following are the findings related to the performance of the experimental groups during the three semesters subsequent to the initial enrollment in the developmental mathematics course.

7. For those students who withdrew from the developmental mathematics course in the first semester there was no significant difference between the tutored and non-tutored groups with respect to the number of students who reenrolled in a subsequent semester. More than 70 percent of all students who withdrew from developmental mathematics reenrolled in a subsequent semester.

8. For those students who withdrew from the college in the first semester there was no significant difference between the tutored and non-tutored groups with respect to the number who reenroll in a subsequent semester. More than 40 percent of all students who withdrew from the college reenrolled in a subsequent semester.

9. For those students who completed the developmental mathematics course, there was no significant difference between the tutored and non-tutored groups in the number of students who reenrolled in a subsequent semester. Approximately 97 percent of the students who completed the developmental mathematics course with a passing grade reenrolled in some subsequent semester.

10. The number of tutored students enrolled in the college in the fourth semester of the study is significantly

greater than the number of non-tutored students so enrolled. While 38.7 percent of the students in the non-tutored group were enrolled in the college in the fourth semester, 86.7 percent of the tutored students were enrolled.

11. For those students who completed the developmental mathematics course in the first semester, there was no significant difference in the numbers from the tutored and non-tutored groups who enrolled in a subsequent mathematics course. Only 21.7 percent of those students who successfully completed developmental mathematics in the first semester later enrolled in another mathematics course.

12. For those students who completed developmental mathematics and enrolled in a subsequent mathematics course there was no significant difference between the tutored and non-tutored groups in the grades received in the later mathematics course.

13. For those students who completed developmental mathematics and enrolled in a subsequent mathematics course there was no significant difference between the tutored and non-tutored groups in the number who withdrew from the later mathematics course.

14. There was no significant difference in second semester grade-point averages earned by students from the tutored and non-tutored groups when grade-point averages are calculated using A = 4, B = 3, C = 2, D = 1, and F = 0. If withdrawal grades are included in the grade average by assigning them a value of zero, students from the tutored groups earned significantly higher grades in the second semester than did students from the non-tutored group.

15. If withdrawal grades are included in the grade average by assigning them a value of zero, students from the tutored groups earned significantly higher grades in the third semester than did students from the non-tutored group.

16. The number of non-tutored students withdrawing from one or more courses in the second semester was significantly greater than the number of students from the tutored groups similarly withdrawing. Of the non-tutored students 73.0 percent withdrew from at least one course in the third semester, while only 31.6 percent of the students from the tutored group similarly withdrew.

17. The number of non-tutored students withdrawing from one or more courses in the third semester was significantly greater than the number of students from the tutored group similarly withdrawing. Of the non-tutored students 70.0 percent withdrew from at least one course in the third semester, while only 31.6 percent of the students from the tutored group similarly withdrew.

In general, students tutored in a developmental mathematics course are more likely than their non-tutored peers to remain enrolled in the developmental mathematics course, to remain enrolled in college, to withdraw from fewer courses, and express more positive attitudes toward their courses during the semester in which tutoring takes place. This pattern of increased persistence continues during the two years following tutoring.

Recommendations

On the basis of the findings of this study the following recommendations seem reasonable:

1. Decisions concerning the use of tutors in developmental programs in community colleges should be based on the probable influence of tutoring on the persistence of students in college and on the development of improved attitudes toward coures rather than on the expectation of higher grade-point averages. The considerable expenses and time expended on the development and maintenance of tutorial programs in the community college can best be justified on the basis of the effectiveness of such programs in building positive attitudes and enhancing self-concepts as expressed in improved short-term and long-term patterns of persistence.

2. In programs or courses in which tutors are employed, effectiveness should be measured by the combination of academic grades, persistence, and change in attitudes toward the program rather than by grade-point average alone. This is especially true for programs designed for academically disadvantaged students.

3. In basic skills or developmental programs in the community college where persistence in college or in the program is a major determinant of the probability that a student will succeed, tutors and structured tutoring should play a major role. In programs in developmental mathematics, reading skills, basic writing skills, English as a second language, or other basic academic skills, long-term persistence is usually necessary for success. It is suggested, therefore, that tutoring should be a central component of such programs.

4. Tutoring should not be seen as a strategy for enhancing the effectiveness of a developmental arithmetic course as a means of preparing low-ability students for success in a subsequent algebra course. This study supplies no assurance that tutoring per se is significantly related to increased probability of enrollment in a subsequent algebra course, or to increased retention or improved grades for students who do enroll in a subsequent algebra course.

5. Tutoring should be considered as a potentially valuable element in the design of instruction in all academic and occupational areas of the community college. This is particularly true in individualized instruction programs and in programs designed for the non-traditional learner who may be more likely than traditional students to withdraw from college or who may have serious unresolved problems relating to negative attitudes, poor self-image, and diminished self-confidence.

6. Further research should be conducted on the relative effectiveness of structured tutoring in basic skills areas other than mathematics: reading, writing, language skills, or general study skills. It is not unreasonable to expect that studies parallel to the present one will yield similar results and extend present understanding of the differential effects of tutoring. Past studies in these areas have suffered from the lack of structure supplied for tutors, and therefore consistent results have not been obtained.

7. Further research should be conducted on the aspects of the tutoring process and the characteristics of tutors that are related to more effective tutoring. In particular, the following factors should be examined experimentally:

   a. the actions or strategies employed by tutors in the tutoring process;
   b. the effects of tutor training;
   c. the effect of matching tutor and student on the basis of cognitive style, personality variables, ethnic, racial, or socio-economic background, or other characteristics;
   d. the role of processes and devices other than programmed-instruction as a structure or framework for the tutoring activities.

8. Further research should be performed to determine the extent to which the positive effects of the tutor-student interaction are due to subject-matter oriented

activities or to the establishment of interpersonal relationships of a more general nature. It would have been enlightening to have followed the progress of a fourth experimental group who were not tutored in mathematics but were encouraged to form an intense personal relationship with another person or group of persons.

9. This research should be extended to student populations other than the educationally disadvantaged. Tutoring is being used increasingly in all areas of community college instruction, including academically talented students and adult and continuing education programs. Most of these applications of tutoring have not been the subject of systematic, controlled investigation, even though they represent important areas of community college instructional activity.

10. Further research should be conducted on the nature of the attitude changes that are apparently produced by the tutoring process. Standardized instruments such as personality inventories or other psychiatric probes should be used to describe and delimit more carefully the attitude and self-image changes occuring during tutoring.

11. Further research should be conducted on the differential effects of tutoring as related to the sex, age, ethnic or racial background, socio-economic background, personality variables, and initial attitudes or tutored students. These factors have not been the subject of study in this investigation. Research on these factors would provide valuable information for tutors and for educational planners involved in developing and managing tutoring programs, training tutors, or developing instructional materials to be used in the tutoring process.

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