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ABSTRACT

To help engineering schools improve their minority student retention rates, the National Action Council for Minorities in Engineering (NACME) undertook a Retention Research Program. The program consisted of two parts. First, NACME funded 11 projects which planned to add to or modify one or more minority student support services. Second, NACME used data from all the proposals originally submitted (51) and from the 11 funded projects to draw conclusions about factors contributing to retention success. Analyses of proposal data revealed that the three support mechanisms significantly related to success were: (1) monitoring of student performance and early warning of academic difficulty; (2) formal interaction among the minority engineering program, its students, and the engineering faculty; and (3) a summer pre-freshman program to diagnose participants' academic strengths and weaknesses and provide the assistance indicated. Analysis of project data yielded a number of significant findings, the most important of which was that retention can be dramatically improved through the addition or modification of one or more support mechanisms to those services already in place. Other findings underlined the importance of the following: summer sessions plus extra coursework during the year; provision of services by a minority rather than an all-students program; improved study skills courses; and students' previous participation in a pre-engineering program, positive academic self-concept, and motives for choosing engineering. (CMG)

THE RETENTION OF MINORITY ENGINEERING STUDENTS

Report on the 1981-82 NACME Retention Research Program

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February 15, 1983

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THE RETENTION OF MINORITY ENGINEERING STUDENTS

Report on the 1981-82 NACME Retention Research Program

EXECUTIVE SUMMARY

In an effort to improve the retention of minority students in United States engineering colleges and to provide insights into how that goal is best accomplished in a variety of institutional settings, the National Action Council for Minorities in Engineering (NACME), invited 131 colleges of engineering to submit proposals for funding additions or modifications of one or more student support services. This report presents findings based upon analyses of data contained in the 51 proposals submitted for funding consideration, students' and project records, questionnaires completed by participants in each of the 11 funded projects, participants' grade reports and site visit reports.

The study was undertaken in order to:

- Establish baseline data and develop an overview of the retention problem
- Determine the generalizability of previous findings based on the study of individual programs
- Determine the potential for improving retention rates by adding or modifying support services
- Identify those student characteristics and behaviors that influence and/or are influenced by program services

- Identify and determine the effects on retention rates of changes in student characteristics and conditions in engineering colleges
- Suggest implementation guidelines that could be used at the college and pre-college levels to improve the retention of minority engineering students.

Prior to their review by a team of consultants, proposals from the 51 institutions were categorized according to whether they were public or private and their past success in retaining minority engineering students. Two or three proposals were then selected from each category. Selections were based on quality of the proposal and the extent to which they contributed to the heterogeneity of the group in terms of: number of years the minority engineering program (MEP) had been operated, types of student support mechanisms that were both in place and proposed; racial/ethnic composition of the students served by the MEP; geographic location, and size of the institution. The eleven colleges chosen for the study were given matching grants of up to thirty thousand dollars each. Here is a summary of the mechanisms established as well as changes in retention from AY 80-81 to AY 81-82 where they could be determined.

- Kansas State University.--Hired graduate student to assist the MEP Director, established a Study Center and coordinated minority engineering students' utilization of services provided by non-engineering minority programs--Freshman retention changed from 80% to 79%.
- Lamar University.--Established a Study Center and provided peer tutoring--Freshman retention improved from 40% to 79%.
- Northwestern University.--Increased the role of the minority student engineering organization during the summer program and the academic year--Freshman retention improved from 92% to 97%.

- Purdue University.--Used peer tutor/counselors and a study skills course on "How to Succeed in Engineering" in the one project designed exclusively for upperclassmen--Retention improved from 82% to 89%.

- University of California at Berkeley.--Coordinated the services provided by non-engineering minority programs--Freshman retention changed from 92% to 93%.

- Rensselaer Polytechnic Institute.--Established a summer program and hired a member of the science faculty to monitor students and advise them promptly of any academic performance problems.--Freshman retention improved from 83% to 95%.

- University of Massachusetts at Amherst.--Added a two-week summer session and extra course sessions during the academic year--Freshman retention improved from 60% to 71%.

- University of Texas at Austin.--Offered counseling and implemented findings from applied research to supplement the services provided through the minority engineering student organization--Freshman retention changed from 58% to 60%.

- University of Washington.--Added a two-week summer session and extra course sessions during the academic year--Freshman retention improved from 62% to 100%.

In addition:

- California State University at Los Angeles.--Added coordinated peer study groups, tutoring and counseling.

- North Carolina Agricultural and Technical University.--Used computer-assisted instruction to teach mathematics to the large number of entering freshmen who required mathematics enrichment.

Since a highly diverse group of projects were funded, it was assumed that the participants were representative of minority freshmen enrolling in schools throughout the country. If they were representative, it appears that the national engineering effort is, in fact, beginning to produce students who are better prepared to succeed in engineering than at the inception of the minorities-in-engineering effort in 1973: 51 per cent were in the top 10 per cent of their high school classes; 48.1 per cent were above the national average on The College Board Scholastic Aptitude Mathematics Test (SAT-M); 66.9 per cent had participated in a program to prepare high school students for engineering college success; 52.1 per cent had taken calculus in high school and 41.9 per cent had taken both chemistry and physics.

Analyses of proposal data revealed that the three support mechanisms that were significantly related to retention success were: (1) monitoring of student performance and early warning of academic difficulty; (2) formal interaction among the MEP, its students and the engineering faculty; and (3) a summer pre-freshman program to diagnose participants' academic strengths and weaknesses and provide the assistance indicated. (Such a session can also convey to students a sense of the pace, competition and performance expectations that characterize engineering schools.)

Analyses of data resulting from study of the various techniques employed by the eleven individual campus retention projects and their participants yielded a number of significant findings, the most important of which was that retention can be dramatically improved through the addition or modification of one or more support mechanisms to those services already in place. Other significant findings and recommendations: (1) summer sessions, even those as short as two weeks, help improve retention if they are followed during the academic year by courses with extra sessions to increase study time; (2) retention is better when services are provided by an MEP or non-engineering minority program than one designed for all students, thus, specialized supports should be maintained and their importance understood; (3) the services provided by MEP's are used more often by students with strong high school preparation and accurate academic self-concepts; (4) study skills courses must be more readily available and carefully scrutinized since they are one of the most desired (by students) but least effectively delivered support services; (5) students who chose to study engineering because they liked problem-solving were significantly more likely to be retained than were those whose choices of an engineering curriculum were based on future salary considerations or similar factors. Thus, career awareness materials must stress the importance of hard work and problem-solving ability in addition to the other attractive aspects; (6) in addition to traditional predictors such as high school mathematics and science grades, recruiters and admissions officers should consider previous participation in a pre-engineering program and academic self-concept in the decision to admit students since both are positively related to minorities' persistence in engineering; (7) minority students who attend high schools with small minority populations usually receive significantly less encouragement from teachers and counselors to study engineering. College recruiters and pre-engineering programs should make a more concerted effort to reach these students; and (8) MEPs should assist student organizations in attracting and involving the more academically able students who have traditionally been underrepresented in them. Student organizations have been shown to be effective in the delivery of support services.

FOREWORD

A national program to increase the numbers of U.S. citizen blacks, Hispanics and Native Americans that enter and graduate from engineering colleges has been underway since 1973. At that time these racial/ethnic groups comprised less than one percent of the profession. Recognizing that industry and others draw heavily upon engineers for leadership, the national effort has been supported by a coalition of private industry, engineering educators, minority advocates and others who have instituted programs at the secondary as well as college levels.

The National Action Council for Minorities in Engineering, Inc. (NACME) was established in 1980, merging the programs of the Minority Engineering Education Effort (ME^3) and the National Fund for Minority Engineering Students (NFMES). The staff of NACME and its Board of Directors comprised of leaders drawn from major U.S. corporations, engineering institutions and other organizations, provide leadership to and coordination within the national minorities-in-engineering program. NACME's programs include, in addition to Research and Retention activities, a $3,000,000 annual scholarship program which funds 12 per cent of all minority engineering students at 125 colleges, as well as a technical assistance program.

With funds granted primarily by major U.S. corporations and the Alfred P. Sloan Foundation, the effort has seen undergraduate minority engineering enrollment grow from about 9,600 (including the University of Puerto Rico) in 1973 to over 30,000 in 1982. The numbers of minority graduates has grown from 1,255 in 1973 to 3,343 in 1982. At the pre-college level, over 50,000 minority secondary students are currently involved in local programs aimed primarily at exposing them to the opportunities afforded by an engineering education and enhancing the mathematics and science preparation needed for its successful completion.

The first numbers of minority students to enter engineering colleges did so with poor mathematics and science backgrounds. For example, 72 per cent of white students, according to an unpublished 1970's study of secondary students in Northern California, were enrolled in calculus-track courses but only 20 per cent of blacks and 25 per cent of Hispanics were similarly enrolled.

Too, as a result in part of the 1960's civil rights struggles, many minority students were not only beginning a new, highly technical, extremely competitive curriculum, but they were also entering predominately white institutions for the first time. Thus, they faced both academic and cultural stresses with few minority peers or faculty from whom they could draw support.

Early minority engineering students were watched closely. It would appear that even today, data about their retention and enrollment rates are more widely available than those of majority (white) students.

Early data on nominal retention--that is, the numbers of graduates versus freshmen entering four-year curricula four years previously--strongly suggested that attrition of minorities was excessive. Either as a result or in anticipation of this finding many engineering colleges instituted minority engineering programs designed to compensate for academic deficits, provide support through academic and personal counseling, and enhance the social environment for their students. At the same time, local, regional and, in some cases, state-wide programs were begun throughout the nation with the goal of producing minority students in numbers better able to qualify for and survive in engineering colleges.

Programs were often begun with little data to support the choice of mechanisms used. Even today college-level minority engineering programs--and there are over 100 in the approximately 280 engineering colleges with programs accredited by the Accreditation Board for Engineering and Technology -- vary widely. They may represent anything from a single person who serves primarily as a friendly role model who can direct a student to services available campus-wide, to an extensive, specially staffed comprehensive program exclusively for minorities that provides ten or more support mechanisms such as academic and personal counseling, role models, industrial plant tours, social activities, student clubs, pre-freshman orientation and/or a pre-freshman on-campus summer session.

Despite these efforts little data have been available that would enable replication of programs particularly suited to another institution's needs, based on enrollment size, ethnic make-up and governance. Whereas many programs are highly successful, achieving minority retention rates exceeding those of white students, many are not. Little data, too, have been available to determine which mechanisms are most related to increased retention.

With more minority students entering engineering colleges each year and fiscal conservatism showing signs of increasing, it is exceedingly important that administrators and funders of both new and already-established programs better understand how to achieve success.

NACME thus undertook the study of minority student engineering college retention in 1981. NACME has access to a wide range of institutions and students for its research efforts. It is a national organization with not only research capabilities but, also, close ties to over 125 engineering colleges by virtue of its minority engineering scholarship program. Additional others are aided by NACME's technical assistance program.

The study summarized in this report reflects NACME's concern for both established programs -- many of which are expanding to meet increased student enrollment -- and those just now being planned. It also takes into account changing financial support and the increasing need to justify the mechanisms to other college administrators and funders. Thus, some of the results in this report may appear obvious to the more experienced while novel and complicated to the less so.

Readers are thus encouraged to remember that there is a wide variety of programs in progress now with a broad range of levels of expertise and results. (In support of the implementation of this study, NACME invites questions as well as the opportunity to provide additional assistance.)

It became increasingly clear, too, as the study progressed, that many of the mechanisms presently used to enhance the retention of minority students could be adopted for all engineering students. Data presented in Peterson's Guide to Engineering Colleges (ed., David Reyes-Guerra and Alan M. Fischer, New York) indicate that the retention of the <u>total</u> engineering population is low, despite the fact that according to Scholastic Aptitude Test scores, engineering students are among the best prepared and most able students currently enrolled in college. Given the current concern regarding engineering faculty and equipment shortages, limited enrollment capability, and the high cost of engineering education, it would seem imperative for engineering administrators to institute measures to enhance the retention of all students. They must also recognize of course, that the successful matriculation of minority engineering students -- whose academic preparation and acculturation is likely to differ markedly (from that of whites) for some time -- will continue to require specialized supports. To that end, campus administrators may wish to examine more closely which services are needed by all students as presently offered, and which are needed by special populations such as minorities.

For their generous, skilled and thoughtful assistance in the successful completion of this study, NACME wishes to extend its gratitude to Dr. Richard T. Mullins, formerly NACME Vice-President for Operations, for its initiation; Eleanor Woodbeck, NACME Administrative Assistant; Dr. Benson Penick, Consultant for NACME, who served as Program Director and whose report follows; Dr. Edwin Stueben, Frederick Hamilton, and Richard Bayne who read and analyzed the proposals for funding; Dean Eddie Knowles, Rensselaer Polytechnic Institute; Dr. Albert Wortham, North Carolina Agricultural and Technical University; Ms. Marion Blalock, Purdue University; Dr. William Brazelton, Northwestern University; Dr. Alfred LaGrone, the University of Texas at Austin; Dr. Joel Nossoff, California State University at Los Angeles; Ms. Mildred Wyatt, University of California at Berkeley; Ms. Karen Hummel, Kansas State University; Dr. Richard Price, Lamar University; Dr. J. Ray Bowen, University of Washington;

and Dr. Ting-wei Tang, the University of Massachusetts at Amherst, the campus directors of the minority engineering programs. Not least, over 500 minority engineering students cooperated by allowing themselves to be interviewed and studied. Finally, NACME acknowledges the contribution of Dr. Lloyd Cooke, President of NACME, who provided many thoughtful additions and suggestions. Throughout, Vivian Briggs, NACME Administrative Assistant, cheerfully typed, scheduled, arranged, checked upon and anticipated the myriad of details that an undertaking of this size involves.

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February 15, 1983

BACKGROUND

For well over a decade, the underrepresentation of U.S. citizen ethnic minorities in engineering has been recognized as a critical problem. Since the 1973 appeal for a "national mobilization," representatives of industry, colleges and universities, secondary schools, engineering societies and community groups have created special projects to increase minority participation. The feasibility and effects of alternative approaches for achieving this goal were reported in publications by the Committee on Minorities in Engineering. These publications (College, 1977, Pre-Engineering, 1979) contained descriptions of approaches for initiating and operating programs designed to accomplish the goal, the elements that seem to be common to successful programs, and recommendations for future directions.

In 1980, administrators of the newly-created National Action Council for Minorities in Engineering (NACME), in reviewing the progress of the "national mobilization," agreed that several factors indicated the need for a new programmatic approach and study. Among the considerations which underlay this decision were:

(1) Evidence that, despite dramatic increases in the enrollment of minorities in freshman engineering classes, overall representation among engineering upperclassmen and graduates had not increased proportionately because of high attrition rates among enrollees.

(2) Despite some basic agreement concerning ways in which to provide the most effective academic support, high enrollments (often leading to more stringent admission and retention standards) in engineering schools and the limitations in

funds available for special academic support suggested the need for determining the most cost-effective ways of improving the academic performance of minority engineering students.

(3) The need to determine how an expanding emphasis on the pre-college performance of minority students was affecting their college experience.

(4) The need for insight into the transferability and generalizability of approaches from one setting with a given participant group, to other settings serving different types of individuals.

Based on its administrators' recognition that the goal of increased minority representation is dependent upon such factors as adequate funding, sufficient numbers of able and interested secondary level students, and increased enrollment and graduation rates, NACME announced a Research Retention Program in February, 1981. The purpose of the Retention Program was to aid schools of engineering in their efforts to provide academic support for minority students. NACME sought to assist minority programs through direct funding and study of retention activities and the dissemination of information concerning ways which Program findings might significantly improve retention and graduation rates.

As part of its Program, NACME sent announcements of its grants competition to 131 colleges of engineering, received 51 proposals in response to the announcement and funded 11 of the 51 proposals received. The resulting study is, thus, based on: data presented in the 51 proposals; information gathered in the context of two site visits to each of the 11 grantee institutions; questionnaires completed by participating students; project records (e.g., student contact logs) maintained by the 11 Project Directors and their staffs; and students' background and performance data (e.g., high school transcripts, semester grades).

Measures generated through the use of these sources were aimed at:

(1) Developing a uniform data base across a wide range of projects.--Since it was anticipated that proposals would be received from engineering projects that varied in terms of their institutional settings and methods of service delivery, applicants were all required -- to as great an extent as feasible -- to provide similar information in a standardized format and, in the case of funded programs, to report data on an individual rather than aggregate basis. Common data bases were considered essential in order to: determine the retention rates of minority engineering students; determine the validity and generalizability of widely-held retention hypotheses based on anecdotal evidence and previous quantitative assessments of individual Minority Engineering Projects (MEP's); and to direct the focus of data collection and observation to be employed in the study of a heterogeneous group of eleven projects.

(2) Determining the extent to which retention rates can be modified.--The principal concern of the study was to determine whether minority retention in 11 engineering colleges could be improved through the addition or modification of one or more specific support services. The study sought

to identify the project and student characteristics and activities that both influence and are influenced by the results of intervention efforts.

(3) Providing guidelines for the improvement of retention.--Site visit observations and interviews were expected to suggest interpretations of the significant relationships and differences identified through quantitative analyses of student and project data. Information gathered from the various sources was also expected to document trends in individual (e.g., type of high school preparation) and institutional (e.g., responses to increased enrollment) characteristics and activities that might significantly affect retention rates.

Expected by-products of the research activities were: 1) a better understanding of the minority students currently enrolling in engineering curricula at the college level; and 2) generalizable findings that could be used by project administrators at the college and pre-college levels to improve the delivery of support services.

The eleven NACME awards provided up to $30,000 in one-year matching funds for project modifications. The funds were designed to enable engineering programs: to modify program services aimed at improving minority retention; to share insights through on-going contact with the NACME Program Director who was examining efforts to improve retention in each of the eleven colleges of engineering; and to contribute to the research activities undertaken in an attempt to discover which services work best, for whom and in what types of settings.

In order to increase the likelihood of accomplishing the above-mentioned objectives, projects were selected in such a way as to ensure the inclusion of: different types (e.g., public/private, new and on-going minority efforts) of institutions and projects; projects with different racial/ethnic compositions among their student participants; geographically dispersed institutions; different delivery mechanisms and agents; and different degrees of past success in retaining minority students. A project's past success was a particularly important concept in that it provided NACME with an opportunity: 1) to fund and observe what appeared to be exemplary retention programs and determine both the reasons for and the stability of that success; 2) to determine the applicability of approaches associated with that success to other projects; 3) to determine whether success could be maintained in the face of changing conditions (e.g., dramatically expanded numbers of minority students, exemptions for minorities from increasingly higher standards for admission, and retention); and 4) to test the extent to which retention could be improved where success had not previously been experienced and/or where there were special problems (e.g., large numbers of commuting students, large on-campus enrollments).

The study was intended to provide useful information with regard to such important issues as: the role of pre-college experiences in the performance of minority engineering students; forms of behavior that are most likely to be changed during the course of project participation; the types of students most likely to change or most in need of experiencing such change; the types of project models, sponsoring institutions and project components that are most likely to effect change; and the role of organizations such as NACME in assisting institutions and projects to achieve more positive outcomes.

Unless otherwise indicated, "retention" in this study refers to the freshman year only. The rationale for limiting discussion to first-year rates lies in the fact that a disproportionate amount of the minority engineering attrition occurs during students' first year. Consequently, with one exception, the retention projects that NACME funded had as their primary goal the improved retention of first-year students.

Throughout, campused-based retention activities are generally described as "projects" to distinguish them from the NACME Retention Study which is referred to as the "Program".

METHOD

THE RETENTION PROJECTS AND PROJECT PARTICIPANTS

The NACME Retention Program was initiated as a demonstration program designed to:

1) Explore the feasibility and assess the effectiveness of having various types of program models used to provide academic and non-academic support aimed at improving minority retention in engineering;
2) Provide an opportunity to observe a range of different activities identified as having potential utility in improving retention; and
3) Provide insight into the problems and solutions characteristic of programs at various stages of their development, serving different minority sub-populations and with varying degrees of prior success in the area of retention.

The 11 projects consisted of:

1) California State University at Los Angeles.--This project employed a single staff person to coordinate study groups. The students it served were somewhat older than most undergraduates, often had family responsibilities and commuted to an environment not previously providing systematic retention services;
2) Kansas State University.--This project hired additional staff members to facilitate the coordination of services

provided by non-engineering minority programs and established a Study Center in the engineering college that could serve as the focal point of a new minority engineering program;

3) Lamar University.--This project established a Study Center in the engineering college that would allow group study in a context close to the mathematics professor responsible for providing most of the academic support received by minority engineering students;

4) North Carolina A&T University.--This institution is a Historically Black College whose project employed computer-assisted instruction in an effort to better serve the large number of students who required enrichment in mathematics;

5) Northwestern University.--This project involved the minority student organization as primary service delivery agent in an established high retention program;

6) Purdue University.--This project used peer tutor/counselors and faculty-taught courses on "how to succeed in engineering" in an effort to improve retention among upperclassmen;

7) Rensselaer Polytechnic Institute.--This project established a summer program--similar to the one attended by specially-admitted students--for regularly-admitted minority students. The project also hired staff members, including a member of the science faculty, to assist in the monitoring of student performance and other tasks;

8) University of California at Berkeley.-- This project hired a Coordinator to encourage engineering students' use of services provided by non-engineering minority programs.

The Coordinator was also involved in planning and monitoring to ensure that the services provided were appropriate for engineering students;

9) University of Massachusetts at Amherst.--This project developed a new summer program and classes with extra sessions during the academic year in an effort to expand the role of faculty members in a context that had previously involved a single faculty member as the principal service provider;

10) University of Texas at Austin.--This project called for the use of applied research and counseling provided by a newly-hired faculty retention coordinator and a graduate engineering student to supplement the service delivery role of the minority student organization; and

11) University of Washington.--This project involved a new summer program and new staff members for the minority engineering project who were to work with existing non-engineering minority programs in the delivery of services.

In light of the diversity represented by the institutions and MEPs selected for participation in the Retention Study, it is reasonable to assume that the students they served were typical of those enrolling in freshman engineering programs throughout the country. If that assumption is valid, anecdotal evidence suggesting that the national mobilization effort is beginning to produce students who are better prepared to succeed in engineering was supported. Of those students for whom background information was provided: 51 per cent were in the top 10 per cent of their high school classes; 48.1 per cent had SAT Mathematics test scores that were above the national average (for all students irrespective of major); 66.9 per cent had participated in a program designed to develop the motivation and academic skills necessary for high school students to succeed in college-level engineering courses; 52.1 per cent had taken high school calculus (versus 46 per cent having taken trigonometry in a 1978 sample studied by the Minority Engineering Education Effort); and 41.9 per cent had taken both chemistry and physics in high school. The implications of this improved preparation are discussed at several points in this chapter.

Each of the minority sub-groups (based on race/ ethnicity and gender) were represented among participants in the projects. Males comprised 71.8 per cent of the respondents and females comprised 28.2 per cent. The sample was 1.7 per cent (9/520) American Indian; 69 per cent (359/520) Black; 18.5 per cent Mexican American (96/520); 7.5 per cent (39/520) Puerto Rican; and 3.3 per cent (17/520) other.

DESCRIPTION OF THE ASSESSMENT MEASURES, PROGRAM AND STUDENT RECORDS

Assessment Measures

Student Questionnaire. A Student Questionnaire was developed for administration to all entering Program students during the first two weeks of school. The instrument was designed to provide information regarding the students' academic background prior to enrolling at the university; demographic information concerning the student and the high schools attended; previous study and work habits; students' perceptions of engineering as a profession and as a field of study; perceptions of self; and expectations concerning their study habits in the engineering program.

Term Completion Questionnaire. The Term Completion Questionnaire was administered to students at the end of the first semester/quarter and yielded information concerning: work and study behaviors during the just-completed term; the type of agent responsible for the academic services most often used, the extent to which those services were used and the perceived quality of those services; the frequency and level of involvement in any minority student organization; characteristics of the classes taken the previous term (e.g., number of students and minority students, type of instructor); and the role of various factors in the student's academic experience.

Program and Student Records

Program and student records consisted of: student contact records that indicated the number and types of contacts between the students and their respective programs; a cumulative retention assessment that sought to determine what the most accurate retention statistics were for each minority engineering effort by identifying the number of students who were transfers, academic casualties, etc., for the past four years, thereby establishing baseline data against which the efforts of the current retention project could be assessed; information from students' high school transcripts and semester/quarterly grade reports and academic actions.

DATA ANALYSIS

The analytical approach to the available data was determined in large part by the practical realities of field studies. Unlike laboratory experiments involving random assignment of individuals to treatment and control conditions and experimenter control over subject participation, programs such as NACME's Retention Research Program involve voluntary student participation, administration of instruments and maintenance of records by individuals with numerous non-research responsibilities and the unavailability of comparable control groups.

While the above conditions sometimes result in inadequacies in the data which preclude the use of more powerful statistical measures, analyses applied in the present study were intended to:

1) Describe Project and Participant Characteristics.--Frequencies, percentages and measures of central tendency and dispersion were used not only for description, but also to show the extent of service delivery, outcomes such as attrition, check on the adequacy of the data through comparisons with results obtained from groups assumed to be similar and provide the basis for determining those variables that should be included in more sophisticated analyses.

2) Analyze Project Differences -- Analysis of variance and t-test procedures were employed to analyze students' perceptions of the quality of specific support services. These

techniques were used to determine whether perceived quality of the services provided in high-retention[1] public institution projects differed from perceptions among students participating in other public institution projects.

3) Determine the Relationships Between Predictor and Outcome Measures -- Predictor variables are the pre-college experiences and achievements, demographic characteristics, perceptions and student behaviors discussed previously in the "Assessment Measures" section. Outcome measures are primarily retention rates for the projects and grade point averages in technical courses for project participants.[2] It should be noted that because of: sample attrition; the failure of all respondents to complete all questionnaire items; and the ability of projects to provide complete background information on all participants, missing data occurred for all measures of association to some extent. Missing data analyses were, therefore, required throughout the study for the analytical techniques used.

1 "High retention" projects, for the purpose of this analysis, were the four public institution projects that either maintained a freshman retention rate in excess of 90% or improved retention by at least 10%.

2 With respect to outcome measures, students' Grade Point Average (GPA) in technical courses was selected, because it yielded a significantly greater relationship to academic actions (e.g., suspensions, probation) taken against students. Outcome categories (i.e., GPAs of 000 - 1.59, 1.60 -1.99 and 2.00 - 4.00) were selected because they most often represent the quantitative criteria for determining suspension, probation and good academic standing. In those instances where grading systems were other than based upon A = 4.00 grades have been converted to a 4.00 system to allow comparisons.

FINDINGS AND DISCUSSION

Two approaches to examining the effectiveness of different retention-improvement strategies were employed. First, the data provided in the 51 proposals submitted for NACME's funding consideration were analyzed as a means of identifying the relationship between the existence of a particular approach at any given college, and the retention success of that institution. Second, differences in the support mechanisms of highly successful projects and less successful comparable projects were identified through analysis of student perceptions and records data collected throughout the study.

FINDINGS BASED ON PROPOSAL DATA

Proposal data were a valuable source of information since: (1) the sample size (n = 51) permitted types of quantitative analyses that would not be possible with only 11 institutions involved in the comprehensive data collection effort; and (2) the discovery of significant relationships and differences between different types of institutions serve to guide the data gathering that occurred in the remainder of the study. The findings from the first phase of the study follow.

Analyses of data on the relationship between retention and the level of financial commitment, types of project directors, and availability of a minority orientation project, did not reveal any significant differences. The following factors, however, were found to make a significant difference:

1) Early Warning. The program feature with the strongest relationship ($p < .01$) to retention was the availability of an

early warning system. Typically, a faculty member employed by the MEP or the project director established direct contact with faculty members who teach minority students. Faculty members are encouraged to provide early feedback on the academic performance, attendance and performance-related non-academic behavior of students. Early warning enabled the students' problems to be addressed in sufficient time for him/her to receive supplemental instruction, enroll in course(s) at a level more consistent with current capabilities or, in the most extreme cases, consider alternative majors without first experiencing academic failure.

2) Faculty Interaction. As suggested above, project/faculty/student interaction is related to retention. Projects in which there are formal relationships between project staff and faculty members (e.g., briefing meetings for faculty members, faculty receptions hosted by the project) or faculty involvement in the delivery of project services (e.g., teaching in a summer pre-freshman program, faculty tutoring) had significantly higher retention ($p < .05$) than those lacking such interactions.

3) Summer Programs. Analyses revealed that retention was significantly higher ($p < .01$) in engineering colleges that offer pre-freshman summer programs. Although summer programs clearly represent a more costly undertaking than the other support mechanisms discussed, recent site visits suggest ways to minimize the costs of a summer program:

(1) many colleges, public ones in particular, draw substantial numbers of students from nearby communities, allowing for relatively inexpensive non-residential programs; 2) minority student summer programs operated under Equal Opportunity Program (EOP)or other mandates are often willing to modify their services to meet the needs of engineering students who meet eligibility guidelines; and 3) by adjusting students' financial aid packages to treat the per/student cost of the summer program as an extension of the fall term, each student bears part of the program cost, thereby reducing the institution's costs.

FINDINGS BASED UPON ANALYSES OF DATA AND OBSERVATIONS OF FUNDED PROJECTS

Project Mechanisms

As noted in the previous section, the extent to which rigorous quantitative analyses could be employed in comparing retention projects is limited because of sample size. However, analyses of students' perceptions[3] and the conduct of site visit interviews/ observations provide insights that suggest refinements in the conclusions based on previous findings and new hypotheses that could be put to empirical tests. These insights are presented in the discussion of specific support services below.

Summer Bridge Programs. Proposal data substantiated the importance of summer programs indicated by previous studies of minority engineering students. It was not clear, however, whether there were minimum durations required for the achievement of improved performance and retention. Based on this study, it appears that summer programs as short as two weeks (see University of Massachusetts and Washington discussions presented previously) can accomplish positive results under certain conditions.

Structured Study Sessions. Projects that establish Study Centers which students can use as they perceive the need demonstrate that this strategy has utility in improving retention. On

3 The section entitled "Student Characteristics and Academic Performance" presents evidence which suggests that students' perceptions as measured by comparisons of their questionnaire responses and records data are quite accurate, in many instances.

the other hand, three of the four high-retention public university projects had extra study or problem-solving sessions which were either mandatory or which were considered part of courses in which the student was enrolled. In the latter case, the extra sessions were taught by the instructor. Thus, the sessions had clear implications for the way in which student performance would be perceived, and were typically well attended. In light of the data on students' tendency not to devote adequate time to study (see next section), structured study sessions should probably be incorporated into most retention projects.

Group Tutoring. The differences in students' perceptions of group tutoring in high-retention public university projects and those of their counterparts in other public university projects were highly significant ($t = 3.29$, $p < .01$). Specifically, students' ratings in the high-retention projects suggest that their group tutoring services were better than those received by students in other public universities. This supports the contention (raised in connection with the above discussion of extra sessions) that structured sessions work best, since the structured sessions all occurred in high-retention projects and were considered to be group tutoring by many of the respondents. Findings with respect to group tutoring also illustrate the importance of minority programs. In the high-retention projects, students with a choice of service providers were significantly more likely ($X^2 = 30.25$, $p < .001$) to use the services offered by the minority engineering project or another minority project (e.g., Equal Opportunity Program), than students in other projects who often used the services provided by the University or his/her department.

Personal Counseling. Although the primary focus in this study was on academic services, attrition may occur because of non-academic problems or in situations that involve poor academic performance caused by personal problems. Thus, it is important to note that assessments of the quality of personal counseling services are very similar to those for group counseling, which is an important academic service. Specifically, students rate counseling services significantly higher ($t = 3.15$, $p < .01$) and are more likely ($X^2 = 11.41$, $p < .001$) to use the services offered by the MEP or EOP in high-retention projects than their counterparts in other retention projects.

Study Skills.[4] Students' assessments of the quality of study skills services did not differ on the basis of the type of institution attended. Ratings of study skills services (in both high-retention and other public university projects) were consistently lower than those given to other services. Thus, it appears that study skills services should be carefully monitored to ensure that they are comparable in quality to other program services.

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4 Study skills assistance usually emphasizes all or some of the following activities: effective listening; time management; reading quickly and with comprehension; test taking; memorization and concentration; effective writing; and reduction of test anxiety.

INDIVIDUAL RETENTION PROJECTS

Tables 1 and 2 present summaries of the retention rates for nine of the eleven projects funded in the current study. Whereas, only two of the funded projects had 90 per cent freshman[5] retention prior to implementation of the Retention Program, 1981-82 first-year retention exceeded 90 per cent in four of the nine projects whose data permitted the calculation of retention rates. Three other projects reported substantial improvement in their retention rates, while two of the projects reported retention rates that did not differ from those of the previous year. Since some of the projects provided data only for those students participating in the retention program, SAT Mathematics test scores were used as a basis for determining whether the academic background of students in the 1981-82 cohort differed from those in the previous year's cohort. In only one case was there a question concerning the representativeness of the group served by the retention project. This will be discussed in the section on individual projects which follows. It is noteworthy that the retention projects are being continued by ten of the eleven engineering colleges. These decisions were reportedly influenced by the success cited above and the fact that 1981-82 minority retention compared favorably with the rates for non-minority students in those instances where such data were available. The intervention strategies and their effects on retention in individual projects follow.

Kansas State University (KSU)

Prior to implementation of a retention project, Kansas State University engineering students received academic support services primarily from the extensive campus-wide Equal Opportunity Program

5 As noted in the Methdology Section, one project focused exclusively on upperclassmen.

TABLE 1

A Comparison of Minority Engineering Students' 1980-81 and 1981-82 Test Scores and Student Retention Rates for Nine of Eleven NACME-Funded Projects[6]

NACME Project	AVERAGE 1980-81 SAT Math Scores	AVERAGE 1981-82 SAT Math Scores	#STUDENTS 1980-81	1ST YR. ATTRITION 1980-81[7]	#STUDENTS 1981-82	1ST YR. ATTRITION 1981-82	RETENTION RATE 1980-81	RETENTION RATE 1981-82	1ST YR. NON-MIN. RETENTION
Kansas State University	23 ACT	23 ACT	75	15	53	11	80%	79%	60%
Lamar University	423	442	120	72	107	22	40%	79%	60%
Northwestern University	550	567	59	5	35	1	92%	97%	
Purdue University	527	533	92	17	27	3	82%	89%	
Rensselaer Polytechnic Institute	625	610	75	13	20	1	83%	95%	92%
University of Ca., Berkeley	Not Available	548	36	3	42	3	92%	93%	
University of Massachusetts	460	466	30	12	34	10	60%	71%	80%
University of Texas	523	520	362	152	88	35	58%	60%	63%
University of Washington	N/A	584	37	14	34	0	62%	100%	
							72%	85%	

6 Data provided by one institution did not allow retention rates to be determined. In a second case, institution had no formal academic action procedures in place. Thus, attrition could not be determined in a manner comparable to ... ployed for other institutions.

7 ... 1979-80 if data for 1980-81 were not available

Table 2

A Summary of Intervention Mechanisms and Retention Results for NACME-Funded Projects

Institution	Project Features Prior to 1981-82	1981-82 Retention Project Features	1980-81 Retention	1981-82 Retention
Kansas State Univ.	No Summer Program; No Minority Student Orientation; No Formal Faculty Orientation. Other Services Provided by EOP.	1. Peer Tutor/Counselors Hired 2. Study Center Established 3. Associate Director Hired 4. Formal Interaction Between Faculty & Tutors Established	80%	79%
Lamar Univ.	Program Run by One Faculty Member Who Provided Most of the Academic Assistance. Monitoring Provided Primarily by One Instructor	1. Study Center Established 2. Peer Tutors Hired 3. Early Warning System Developed	40%	79%
Northwestern University	Comprehensive: Summer Program; Early Warning; Minority Orientation; Faculty Involvement in Program.	Expanded Role for Student Organization in the Summer Program and Support Services (e.g., Tutoring) During the Academic Year.	92%	97%
Purdue Univ.	Limited Services for Upperclassmen Provided by Individual Departments.	1. Peer Tutor/Counselors Hired 2. Departmental Advising Supplemented 3. Study Skills, "How to Succeed in Engineering" Course Taught in New Program	82%	89%

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Institution	Project Features Prior to 1981-82	1981-82 Retention Project Features	1980-81 Retention	1981-82 Retention
Rensselaer Polytechnic Inst.	Comprehensive: MEP Had a Director & 5 Full-Time Staff Members (See Northwestern for Services)	1. Summer Program Expanded to Include Regularly-Admitted Students in Addition to EOP Students 2. Science Faculty Member Hired to Design Courses, Monitor & Advise	83%	95%
U. of CA at Berkeley	Full Range of Support Services (e.g., Summer Program, Structured Study Sessions) Provided by Non-Engineering Organizations	1. Facilities Provided by MEP 2. MEP Director Hired to Coordinate Services 3. Associate Dean Provided to Facilitate Faculty/Program Interaction	92%	93%
U. of MA at Amherst	Full Engineering Professor & a Staff of Two Provided Tutoring, Counseling & Faculty Liaison Activites. Counseling & Advising Also Provided by Other Minority Organizations.	1. Developed a Two-Week Summer Program 2. Extra Workshops Added to Courses During Academic Year	60%	71%
U. of Texas at Austin	Student Organization Provided Tutoring. Other Services Available Through EOP.	Assistant Hired to Provide Tutoring & Counseling Within the College of Engineering. Applied Research Employed to Identify Retention Problems & Suggest Solutions.	58%	60%
U. of WA	Services Previously Provided Through EOP.	New MEP Featured a Two-Week Summer Program & Expanded (i.e., Four Weekly Sessions vs. Three) Courses. Program Run by Two Engineering Faculty & Technically-Trained Staff	62%	100%

41 42

(EOP). Although the Director of the Minority Engineering Program (MEP) worked closely with administrators of the EOP, she also had responsibility for the Women's Program and was therefore not in the best position to ensure that services provided by the EOP were always appropriate for engineering students.

The retention project established a Study Center with study carrels and computer terminals in the engineering building, provided for an Assistant Director, provided a graduate student who monitored the Study Center and provided counseling and tutoring services to the students and provided training for peer tutors.

While the retention rate did not improve and the number of hours/week the Center is open should be increased, several positive indicators suggest that future retention may show the desired improvement. Among the indicators are:

1) As the benefits of the program became more obvious during the course of the year, stronger students began to participate.[8]

2) Program improvements have been such that graduates are now expressing an interest in staying on to help with its administration and service delivery while they pursue graduate degrees.

3) With the Study Center and Peer Counselor system to be housed in expanded space provided by the College of Engineering, visible support mechanisms designed specifically for engineering students should enable the program to reach more students and build a cadre of qualified students who can provide assistance to others.

8 As this was the first year of a systematic program effort, the time required for dissemination of information about its existence and overcoming skepticism about its effectiveness suggest that the 1982-83 results should be a better indicator of the project effectiveness. The Project has agreed to continue providing data so that NACME can make this determination.

4) In order to better administer the expanded 1982-83 activities, a new Director whose responsibilities are confined to minority students (versus also being responsible for the Women's Program) has been hired.

Lamar University

Prior to implementation of the retention project, academic assistance for minority engineering students was provided primarily by one minority faculty member on an individual basis. Because of the small number of students enrolled several years ago, this approach was reasonably successful. As enrollment grew, however, it became clear that if more than a few students were to be helped, other support mechanisms would be needed. An initial step in this direction was taken by the establishment of a Study Center provided through the retention grant. The Study Center contained a terminal that communicated with the Administration's central processing unit of which the minority students had almost exclusive use during non-business hours.

By establishing the Center in close proximity to the Dean of Engineering's Office, it was assured of high visibility, often used by students who had an hour between classes; and maximized the assistance provided by the faculty member who could then help students on a group, rather than an individual, basis in a setting a few feet from his office. The Center led to the formation of a number of informal groups -- including upperclassmen who often were commuters and had difficulty availing themselves of other group-study opportunities on campus.

The steps taken by the retention project produced the largest retention increase in the entire study. It appears, however, that the support system should become more institutionalized and less dependent on the efforts of the one faculty member; should involve a greater percentage of the minority student population in order to strengthen the peer-help possibilities; should consider the advantages of a summer program, since the majority of Lamar's students are from the surrounding three-county area and would not have to be provided food and housing, which are the most costly items in residential summer programs. Because of the positive perceptions of minority students in the College of Engineering (where minority retention rates now exceed those of non-minority students), an increased role for other faculty members would also seem to be a desirable and readily achievable objective.

Northwestern University

Northwestern used its retention award to provide members of its minority student engineering organization with expanded opportunities for involvement in a Summer Bridge Program[9] as tutors, counselors, etc. Given the increasing responsibility the group had assumed for providing academic support services to minority engineering students, it was felt that this approach might serve as a good opportunity to determine whether a school with a well-established program and excellent retention could continue to provide good support services on a more cost-effective basis (i.e., by using more peer help) and continue to achieve excellent retention results.

9 A Summer Bridge Program is a session which is designed to facilitate students' transition from high school to college. These programs typically offer opportunities for several of the following activities: orientation to the campus, the engineering curriculum and the engineering profession; diagnostic services; remedial instruction; supplemental instruction; exposure to the instructional pace, performance expectations and competition encountered in engineering programs.

Data suggest (retention remained above 90%) that a reduced role for the College of Engineering in direct service delivery and an expanded role for student organizations may be possible in well-established programs. This statement is not to suggest that the College of Engineering or University should/or has abdicated its responsibility. Instruction in the Summer Bridge Program continues to be provided by the faculty and the Associate Dean of Engineering, himself, tutors the weakest students, thereby demonstrating to all faculty members that the success of all students is a major priority.

Purdue University

The Freshman Engineering Department of Purdue University provides comprehensive services to all freshman engineering students. The scope of Purdue's freshman services is usually found only in programs for students considered to be "disadvantaged," consequently, the services are effective to the point that no additional services are required for minority freshmen. Beyond the freshman year, however, engineering students enter individual departments, e.g., Mechanical, Electrical Engineering, where student support is considered to be uneven.

In an effort to ensure that minority students not only achieved good grades, but also avoided course overloading and bypassing of the more difficult courses necessary for making progress toward graduation, Purdue proposed to operate the only program aimed exclusively at upperclassmen. While the retention of upperclassmen increased 89 per cent from 82 per cent previously, other indicators were perhaps even more impressive. By offering peer assistance and a study skills/reorientation course taught first by an MEP staff member and then by an engineering faculty member, a greater number of students (relative to a control group of similar students who declined to participate) made substantial progress toward graduation -- as opposed to passing grades in nonessential courses -- and more students who were on probation were able to return to good academic standing. While it might be argued that a program for upperclassmen suggests a continuation of "hand-holding," an alternative interpretation of this situation is that when there is a systematic commitment to quality educational services, minorities need no special assistance, but when the quality and extent of service is uneven, minorities may be more greatly disadvantaged. If the latter interpretation is accepted, then the answer to the question "when does the need for special help disappear?" is "when a cadre of people are available who have had the advantage of a positive experience that can be communicated to those who follow."

Rensselaer Polytechnic Institute (RPI)

RPI has a "two-track" project, one for regularly admitted minority students and another for Equal Opportunity students.[10] Since the summer session offered for EOP students had proven to be beneficial, a similar experience for regularly admitted students was funded as the major component of the retention project. RPI's previously good retention rate (83 per cent) increased to 95 per cent during

the period the retention project was operative. In addition to the Summer Bridge program, a quarter-time faculty member was assigned to engage in informal advising and to monitor student progress.

10 EOP students are those who, because of limited educational experiences and/or low socioeconomic status, are likely to encounter difficulty in achieving academic success. At RPI, the mean SAT-Mathematics score for entering EOP students was approximately 100 points below that of regularly admitted minorities and 175 points below that of non-minority students.

through his peer network. The perceived success of the retention effort was such that RPI has continued its operation with independent funding this academic year. Among the reported benefits were: an opportunity for minorities to take a reduced load during the academic year (when despite relatively high aptitude scores, they are competing with some of the best students in the country); an opportunity for early diagnosis of academic weaknesses (e.g., physics) and the development of course modifications and other approaches to facilitate their elimination; and an opportunity for students to develop a more intimate knowledge of the opportunities for individual, group and student/faculty research in advanced areas in which the Institute specializes. Thus, the expectation is that retention projects at institutions such as RPI may improve the quality of the graduate rather than improve the rate of graduation, which is already quite high.

University of California at Berkeley

Berkeley's retention project employed an MEP Coordinator to maximize the effectiveness of support services offered to engineering students by other campus programs designed to assist minority and disadvantaged students. The Coordinator also was responsible for ensuring that students were aware of and availed themselves of the existing services. The already high retention rate (in excess of 90%) did not leave room for much improvement. Yet, a small gain was noted. This gain occurred despite the fact that the Coordinator was also involved in generating research that demonstrated the ability of minority students entering with test scores below the newly-adopted cut-off point for admission to succeed in the Berkeley engineering program; recruiting a 1982-83 class of over 100 minority students; and planning a study and approach to address the computer science problems which continue to trouble minority students. One of the keys to the success of the Berkeley project is the structured study environment and the high percentage of students (94.7%) who participate.

University of Massachusetts (U. Mass.)

U. Mass. sought to improve its retention by adding a two-week summer session and extra course sessions during the academic year. The MEP Director and two Assistant Directors continued to be involved in instruction (e.g., problem-solving workshops) as well as project administration. Extra course sections are typically taught by the regular instructor who simply conducts four class periods, rather than the usual three, for example.

While it was unclear whether a two-week summer session would provide ample time to accomplish the MEP's retention improvement objectives, the demonstration nature of the present study suggested that it was worthy of examination. Not only did the summer session and the extra sessions during the academic year foster improved retention at the University of Massachusetts, but the fact that minority students entering engineering are now better prepared than previously, means that a student who has missed some concepts in his/her high school studies or has an unrealistically positive academic self-concept can be assisted during a short session. While severe deficiencies cannot be remedied in two weeks, individual points can be clarified and the performance expectations, work load and level of competition made clear. Moreover when the person who is to teach the course in the Fall semester starts his/her course during the two-week summer session, extra time is provided for diagnosis of students' strengths and weaknesses and overcoming their reluctance to or reservations about seeking help and asking questions.

Because the project has not existed in its present form for very long, a cadre of strong students who can communicate the importance of timeliness, maturity, etc., has yet to be developed. Whether this occurs will depend in large measure on U. Mass.' ability to increase the yield of its minority student recruitment effort--a matter which is currently of great concern to the MEP staff.

University of Texas at Austin

Texas used its retention funds to support a faculty retention coordinator and hire a graduate student whose responsibilities included counseling students experiencing academic difficulty and directing those individuals to the appropriate sources of help. It also used funds to attempt to determine why students leave the program and/or achieve poor grades. While the retention rate did not increase, much was learned about factors likely to influence its improvement:

1) It became clear that it is necessary to cooperate with the Admissions Office in order to identify students prior to their arrival on campus. Early identification will allow the project to make students aware of supportive services before they experience academic difficulty;
2) Where the size of an institution does not permit the performance of students in large classes taught outside of the department to be readily monitored, tutoring and group study efforts can be organized in such a way as

to make the review of tests, quizzes and graded homework which indicate the caliber of student performance part of the routine instructional process;

3) Because of the major service delivery responsibility that student organizations are likely to assume in engineering colleges with large minority enrollments, the guidance and direction received by such organizations is critical; and

4) In addition to utilizing the support mechanisms offered by programs such as the EOP, the MEP must make an aggressive effort to provide retention services when specially-targeted funds have been established to assist and improve the condition of minorities throughout the University.

University of Washington (U.W.)

The retention improvement mechanisms implemented at U.W. are very similar to those described in connection with U. Mass. The major difference is that rather than being headed by an engineering faculty member actively involved in day-to-day service delivery, most of the services are provided by EOP faculty and MEP staff. Also, the summer program did not involve participation by the entire minority freshman class; rather it was a Minority Introduction to Engineering (MITE)[11] program whose participants are likely to be better prepared than the average minority freshman irrespective of the summer experience. Thus, since data were reported only for the summer

11 MITE is a two-week residential program sponsored on 2-3 dozen engineering college campuses each summer by the Accreditation Board for Engineering and Technology. It can feature a variety of activities. Typical participants are recommended by high school personnel.

participants, the dramatic retention improvement may be somewhat spurious. Nevertheless, retention of any group of minority students that exceeds 90% is commendable. Moreover, the extremely positive attitude of the participants and their desire for excellence which resulted in two-term grade point averages that exceeded the non-minority average, suggests that by working with an expanded group of students and adopting some of the approaches developed by other departments for use with less-well-prepared students, excellent retention for all students can be accomplished.

California State University at Los Angeles (CSULA)

Because of conditions such as: the year-round nature of the University; the large number of students who have family and other responsibilities that require that they drop out for a time, but who, ultimately, return; and the tendency of students to change from full to part-time status and vice versa, it was not possible to develop a retention rate that would be comparable to those for other institutions. Yet, a number of valuable insights can be gained from the retention project's experience at CSULA. First, it is clear that the scheduling problems caused by students who both work and commute are such that the coordination of any support services that are to be provided, will require the attention of an individual who has that task as his/her primary responsibility. Second, by pairing a strong student with less able students, it is possible to organize the study groups that help the latter without appearing to penalize the former -- should resources or other considerations preclude other, possibly more desirable, options. Third, because of their greater flexibility and self-interest, members of student organizations may be the best vehicles for retention improvements in this kind (i.e., large numbers of students who commute) of setting. If, for example, support services should be provided outside the normal work week, the student organization should be better able to accomplish the task. As noted in connection with the University of Texas, the early identification (and in this case, the tracking) of students is essential if information relative to the availability of services is to be readily disseminated.

North Carolina Agricultural & Technical University (NC A&T)

North Carolina A&T sought to improve its retention by developing a computer-assisted instruction course for the large number of students requiring mathematics enrichment. However, since the University had no operative academic action procedures, retention figures comparable to those of other institutions could not be generated. Site visits, however, revealed that the use of computer-assisted instruction (CAI) requires software that provides students with more accurate information concerning errors than, for example, "one variable has the wrong sign." If students have computational weaknesses these must also be addressed, or use of the terminal will be a more frustrating experience than written tests that can identify whether the problem is being properly set up and other errors in logic. Also, by using the computer in conjunction with a word processor students could be given written homework assignments that will give them practice in the areas where it is most needed.

Unlike the previous section in which the project was the unit of analysis and retention rates were the primary outcome measure, this section focuses on project participants and employs their mathematics and science grades[12] as the principal outcome measures. By analyzing student outcomes and the factors related to differences in those measures, insights can be obtained that are potentially valuable not only to the recruiting and student service operations of colleges programs, but also to secondary schools, pre-engineering programs, students planning to study (or currently studying) engineering and parent/community organizations.

Findings involving "input" (e.g., pre-college experiences) variables will be presented first followed by those more closely related to students' college experiences (e.g., hours/week devoted to study). Both types, however, will be discussed in terms of their applicability to the activities of both pre-college and college programs.

Because of the relatively large amount of tabular information, only a summary table (see Table 3) is presented in the body of the report. Tables showing the actual distributions upon which analyses were based are reserved for inclusion in the Appendix, where they are presented in the approximate order of their mention in the text.

Traditional Predictors

The extent to which traditional measures predict the college success of minority students is often the subject of considerable debate. As a consequence, most college admissions officers employ multiple measures and then make allowances for factors such as

12 See "Method" section for a discussion of the relationship of freshman grades to retention.

TABLE 3

The Relationship Between Individual Behaviors, Characteristics and Grade Point Averages in All 1981-82 Technical Courses for All Retention Project Participants.

CHARACTERISTIC	CORRELATION WITH TECHNICAL COURSE GRADE POINT AVERAGE[13]
Academic Background/Pre-College Experiences	
Mathematics Grades in High School	.448**
Exposure to Calculus in High School	.055
Science Grades in High School	.331**
Number of Courses in High School	.126
Race/Ethnicity of High School Attended	.083
Pre-Engineering Program Participation	.190**
Science Fair or Other Competition	.033
High School Rank	.212*
SAT-Verbal Test Score	.104
SAT-Mathematics Test Score	.182*
Demographic Characteristics	
Race (Black/Hispanic)	.192*
Gender	.084
Perceptual	
Appeal of Problem-Solving versus Other Aspects of Engineering	.499**
Academic Self-Concepts	.151*
Accuracy (based on High School Mathematics Grades) of Academic Self-Concept	.356**
Accuracy (based on High School Science Grades) of Academic Self-Concept	.275**
Student Behaviors	
Frequency of Attending Meetings of the Minority Student Organization	-.147
Level of Involvement in the Minority Student Engineering Organization	-.108
Frequency of Contact With the Minority Engineering Program	.248*
Number of Hours/Week Spent Studying	.237**
Race of Study Partners (Black Only)	.273*

* $p \leq .05$
** $p \leq .01$

13/ Technical Grade Point Average represents the average grade for all mathematics, physical science and engineering courses taken by a given student during the 1981-82 academic year. No distinction was made between pre-calculus and calculus grades, but lower-level mathematics courses and science courses other than chemistry and physics were not included in any GPA computations. As noted in the "Method" section, technical grades had higher correlations with engineering retention and were, therefore, used instead of GPA.

recommendations and students' extracurricular activities. The importance of predicting success, however, is not limited to admissions decisions. By identifying populations that are at risk, special support services can be provided at an early point should such students be admitted. Unfortunately, use of predictive indices in this manner is the exception.

Table 3 indicates that some traditional measures of students' academic ability are strongly related to successful completion of technical courses by freshman minority engineering students. The highest correlations are those between high school grades in mathematics and science courses and freshman performance. The strength of these relationships for engineering students is not surprising since many institutions have found that high school rank is the best predictor of success for all freshmen. Given the importance of mathematics and science in the study of engineering, one would expect that verbal measures and high school rank -- that includes performance in courses in which verbal ability is extremely important -- would be less accurate predictors of success for engineering students than for students enrolled in other curricula. As hypothesized, high school rank is a weaker--but still significant--predictor of academic performance, while SAT-Verbal test scores are minimally related. Students' SAT-Mathematics test scores correlate significantly with performance, but produce lower coefficients than any of the other significant predictors.

The quality of instruction in minority high schools is, for a number of reasons, often less adequate than comparable instruction in non-minority high schools. Moreover, Morning et. al (1980) summarize a number of studies which indicate that the disparity is particularly acute in the areas of mathematics and science. In light of the above, it was hypothesized that students from minority high schools would have weaker backgrounds and therefore would have lower grades in their technical courses in college. To the contrary, Table 2 indicates that there was no significant relationship between race/ ethnicity of the student body at one's high school and one's college grades. Although students who attended predominantly white or integrated schools were significantly more likely ($p < .05$) to have taken calculus in high school, many students who attended minority high schools were able to succeed without having that exposure. Their ability to do so appears to be related to the fact that they are significantly more likely ($p < .01$) to have had the advantage of participating in a pre-engineering program--an experience which is, itself, significantly ($p < .01$) related to successful competition of first-year engineering curricula--than their counterparts from non-minority schools.

Because pre-engineering programs are extremely diverse, it was not possible in the context of this study to determine which of their features are responsible for the relationship between participation and college grades. Several phenomena that well may be operating simultaneously are:

1) More encouragement by high school teachers to prepare for and pursue engineering degrees.-- The interaction between pre-engineering program staffs and teachers in the schools attended by program students, could well be responsible for the signficiantly greater ($p < .05$) encouragment (by

teachers) to pursue engineering degrees, by students attending minority high schools than those attending predominately non-minority high schools.[14]

2) Reviews of fundamentals, exposure to the engineering profession, exposure to students currently enrolled in engineering schools-- through program-sponsored trips--and the development of realistic perceptions (see below) about the college reasons why pre-engineering participation may be related to college success. Perhaps by: expanding their operations to serve more minority students attending white high schools--as suggested by the findings discussed above; and placing a greater emphasis on academic (versus motivational) activities called for by many persons familiar with minority issues, pre-engineering programs become even more effective.

Demographics

As reported both anecdotally and in numerous other studies of both minority students' aptitude test scores and academic performance, black engineering students in this study achieved significantly ($p < .05$) lower grades than other minority students.[15] While the difference in other studies has usually been attributable to the relatively poor performance of black males, that was not the case in this study.

14 It is disturbing to note that minority students attending predominantly white schools not only report getting significantly less encouragement from teachers, but also substantially less encouragement from college recruiters.

15 Since American Indians were not represented in sufficient numbers in the sample to allow comparative analyses, comparisons involved only blacks and Hispanics.

Black males and females had similar test scores, high school grades and college performance. When compared with Hispanics, however, blacks had substantially lower ($p < .10$) high school science grades and SAT-mathematics test scores, as well as somewhat lower mathematics grades. Thus, performance differences appear to be primarily related to differences in high school preparation.

In light of the above-mentioned differences on measures related to college performance, it is not surprising that there would be significant racial/ethnic differences in the technical grades earned by Hispanics and blacks. Because of the persistence of these racial/ethnic differences, any pre-college study undertaken should seek to identify pre-college and college programs that have achieved success with black students whose scores on predictive indices are low and for poorly prepared students, in general.

Although sample size was such that there were no overall gender differences, Hispanic females experience the greatest difficulty of any minority sub-group. This finding is supported by anecdotal evidence, and underscores the need for programs to be mindful of cultural factors in providing support services. Specifically, Program Directors familiar with the problem indicate that they have begun to seek the cooperation of community organizations in an effort to communicate the importance of family support for their daughters as well as sons attending college. Program Directors also report working with pre-college programs to address the problems of both academic and non-academic attrition--especially since the latter is often an equally or more substantial problem for the Mexican-American female.

Perceptions

Because of concerns articulated by numerous persons involved in various aspects of the minority engineering effort, questionnaires and interview protocols used in the present study included several items designed to provide information concerning the way in which students' perceptions may influence their academic performance or behaviors related to academic performance. Analyses of perceptual data revealed a number of significant relationships that are discussed below.

The most highly significant correlation involved students' primary reasons for deciding to study engineering. The strong relationship between the appeal of problem-solving and students' subsequent success in technical courses suggests that current career awareness and recruiting approaches and materials must emphasize the importance of and rigor associated with this aspect of engineering. The message that engineering offers financial rewards and a good background for careers in business and other professions is an attractive incentive, but without a simultaneous emphasis on the effort required to succeed, may serve to attract students with little willingness to devote the time to study and the interest in problem-solving generally required for successful completion of an engineering program.

Many studies of minority student achievement, including the Committee on Minorities in Engineering's (1977) report on progress of the national effort, have cited negative academic self-concepts as a factor related to the poor performance of minorities. In the absence of information suggesting that this phenomenon does not apply to minority engineering students, data compiled in the present study might have been interpreted in a similar manner. The significant relationship between perceived ability and academic performance indicated on Table 3 is, in fact partially, the result of students perceiving themselves as "weak" and subsequently performing poorly.

Further analyses of the above-mentioned data, however, reveal that the accuracy or underassessment of one's perceptions are the factors that correlate most highly with successful performance. Most students who see themselves as below average have high school mathematics and science grades that are consistent with those perceptions and as a result don't perform well. On the other hand, those students whose high school backgrounds suggest that they accurately perceive themselves as "Better than Average" or "Average" experience considerable success as do those who perceive themselves as "Average", but who have, in fact, performed well in high school.

Students who experience the greatest difficulty are those with inflated academic self-concepts. Because they see themselves as more competent than they really are, they are considerably less likely to use the services of the minority engineering program or devote an adequate amount of time to study. Discussions with students, faculty, Project Directors and others suggest that this phenomenon is largely due to students' increased exposure to technical courses in high school and other experiences that suggest their competence. Since inflated self-concepts often result in early failures, many students seem to then experience a total loss of confidence or rationalize their deficiencies by blaming others. This finding poses one of the most serious challenges to the success of minority engineering students and a serious dilemma for the staff of support programs. The question that must be resolved is how one builds a student's confidence, while encouraging a proper perspective on the competition, stringent performance, expectations and rapid pace that characterize engineering colleges today.

STUDENT BEHAVIORS

Using the Services Provided By the Minority Engineering Project

In addition to their main effects, students' academic backgrounds, demographic characteristics and perceptions also function as "mediating variables" (i.e., they influence behaviors which, in turn, are related to academic performance). This phenomenon is best demonstrated by the analyses of students' interactions with the minority engineering project. As indicated in Table 3, there is a significant relationship between the frequency of students' contacts with the program and their academic performance ($p < .05$). Undoubtedly, the relationship between program contact and performance is, in part, a function of the academic and non-academic suppo t provided by the projects. In addition, however, frequent project users had significantly higher high school mathematics grade substantially higher science grades and more accurate perceptions of their academic ability -- all characteristic of students with better college performance.

The above findings suggest that projects: must assess the services they provide to ensure that they do, in fact, provide high quality assistance; should strive to convince pre-college directors and parents to encourage students to avail themselves of the minority engineering project once they enroll in college; must point out -- through the use of supportive data--to students in orientation, the importance of using the minority project; should work to ensure that students understand the college environment sufficiently to develop realistic perceptions of their ability; and make certain that "creaming," i.e., focusing on the "best and the brightest," does not unintentionally become a basis for service delivery.

Hours/Week Devoted to Study

Table 2 indicates a significant relationship between the amount of time devoted to study and students' technical grades. This finding is not surprising and is consistent with the programmatic finding that three of the four public institutions in which retention was exemplary or considerably improved had extra courses and/or study sessions, while none of the others (public) had them. The finding is also consistent with faculty members' perceptions that students, irrespective of race, are unaware of the amount of time required for success in the study of engineering. It is somewhat disappointing to note that, often, students fail to internalize and/or minority projects fail to communicate the importance of long hours of study. The existence of either (or both) phenomenon(a) is suggested by students' questionnaire responses. Analysis of their responses indicate that 67.8 per cent of students responding to the entry Student Questionnaire expected to study less than the typically articulated minimum of two hours for each hour of class, and 72.8 per cent of those responding to the question of how much they actually studied stated that it was, indeed, less than two hours per class. It was interesting to note that the number of hours studied was unrelated to number of hours worked, thus, it appears that the issue is one of time management and discipline, rather than insufficient time for study due to the conflicts posed by working.

Attending Meetings of and Degree of Involvement in the Minority Student Engineering Organization

Student performance was not significantly related to the frequency with which students attended meetings of the student organization. There was also no significant relationship between level of involvement in the organization and performance. In both instances, however, those with "little" or "no" responses had somewhat higher grades. On the other hand, those who were infrequently or never actively involved had significantly higher SAT-Mathematics scores and those who infrequently or never attended, had substantially better scores. Thus, it appears that the potentially positive effects of student organizations are often negated by their inability to attract the better student. The cooperation of organizational leaders and MEP Directors is essential if the students are to have the benefit of the student organization as an additional resource.

Study Patterns

There were no significant overall relationships between patterns of group and individual study. This is probably due to the overwhelming tendency of respondents to study with non-minority students as well as other minority students. Secondary analyses did, however, reveal that there was a significant ($p < .05$) negative relationship between black students' grades and the extent to which they studied with non-minority students. Previously discussed data indicated that minority students often suffer from inflated academic self concepts, do not devote adequate time to study and may have had little previous exposure to non-minority students in high school. Thus, it is not surprising that there would be instances in which non-minority students who might be less familiar with the above-mentioned behavior than another minority, would probably not interact in the study group in ways that would be advantageous to the minority student. It may be as simple as one's behavior not fitting the established level of expectations one establishes for a study partner. Projects must address this problem as part of their overall effort to develop accurate perceptions and behaviors among their students. This is especially true in those instances in which the relatively small size of the minority engineering population makes it imperative that one learn to interact with non-minority students in study groups.

RECOMMENDATIONS

A number of the findings presented in this report have implications for the way in which MEPs are operated and retention strategies are implemented. The recommendations presented below are based on these findings and offer guidelines that those concerned with both college and pre-college programs may wish to consider.

(1) Despite the worsening fiscal situation in many institutions of higher education, minority engineering programs must be maintained because of evidence that they are probably best equipped to provide minority students with high-quality service. In this connection, the disparity between the amount of available scholarship and programmatic funds must be addressed since data suggest that without a support program even very qualified students may become academic casualties unnecessarily.

(2) Early identification of minority students must occur if a greater portion of them are to be served by the MEP, and if that intervention is to occur prior to the onset of academic problems. By establishing cooperative relationships with the Admissions offices, the MEP should be able to initiate contact with minority students in sufficient time to establish a mechanism for early warning which is one of the features characterizing effective comprehensive programs.

(3) Just as there is a need for interaction between the MEP and University offices, there must also be interaction between the Program and the faculty community. This interaction will

facilitate early monitoring and warnings regarding student performance. It will also ensure that the program staff is aware of changing situations and has support for its responses to those changes (e.g., increased admission requirements).

(4) Summer programs should be held even if they are as short as two weeks (in those instances where students may have good preparation, but possess gaps in certain areas or attitudes/perceptions that are likely--based on past assessments--to pose difficulties if not resolved). Because one of the major deterrents to the establishment of summer programs is the cost associated with them, schools and funding sources should reconsider those policies that do not permit students to use their financial aid for summer study.

(5) Structured extra sessions, whether they involve starting a course a few weeks before students would normally begin (thus creating, for example, a twelve-week vs. ten-week term) or an extra session on a weekly basis appear to be one of the most effective approaches to improving retention. These sessions should be held in connection with specific courses and, when possible, taught by the instructor, so that their importance is not lost on the student whose inclination is--given a choice--often to not devote adequate time to study.

(6) Study skills courses are one of the most desired, but least effectively delivered, services currently provided. Thus, the service must be made more readily available and must be carefully monitored to ensure its quality.

(7) Projects must: assess the services they provide to ensure that they, in fact do, provide quality assistance; strive to convince pre-college program directors and parents to encourage all students to avail themselves of the minority engineering program once they enroll in college; point out--through the use of supporting data--to students in orientation sessions, the importance of using the minority program; work to ensure that students understand the college environment sufficiently to develop realistic perceptions of their ability; and make certain that "creaming," i.e., focusing on the "best and the brightest," does not unintentionally become a basis for service delivery.

(8) Individual projects must collect and analyze data to determine how hypotheses generated by studies such as this and recommendations contained herein can be translated into effective programmatic approaches to retention improvement in their respective settings.

(9) As studies such as this begin to specify the types of program and activities that can facilitate retention, support should be targetted for those institutions whose commitment and approach offer a reasonable opportunity for success. Information regarding the availability of services and the importance of those services to retention, should be made part of every funder's, counselor's, student's and parent's program selection checklist.

(10) Career awareness materials and recruiting approaches must stress the importance of hard work and problem-solving ability if one hopes to succeed in engineering. Approaches that emphasize financial gains and fail to emphasize the level of effort required to succeed in engineering often contribute to misperceptions on the part of students who have not worked hard in high school and have done little to understand or meet the challenge they will face as freshman engineering students. These materials and approaches should also note the overall effectiveness of minority engineering programs and encourage students, parents, counselors and others to consider the strength of specific programs along with other criteria used to select a specific engineering college.

(11) Despite the predictive ability of several of the traditional measures--particularly if used in conjunction with one another--other considerations that are shown to be related to success (e.g., participation in a pre-engineering program, accurate academic self-concepts) should be examined within individual institutions to determine their ability to enhance the admissions and placement processes--especially for marginal students.

(12) College recruiters must visit non-minority high schools and encourage minority students attending those schools to consider enrolling in an engineering program. This activity is particularly

important because of the preparation students tend to receive at those schools (e.g., four years of math) and the relative lack of encouragement they receive from teachers to pursue an engineering career.

(13) Pre-engineering programs, because of their demonstrated effectiveness in improving retention, should expand their focus to include more students from integrated and predominantly white high schools.

(14) A study of pre-engineering program elements should be conducted to determine how different activities, service delivery agents and program demographics differentially affect different types of students. This study should be similar to the one described herein and should follow students through their freshman year in engineering school, as well as track their progress in high school (for those students entering the program at the lower grade levels).

APPENDICES

TABLE 1

The Frequency Distribution of Students' High School Mathematics Grades and College Mathematics/Science Grade Point Averages

High School Math. Grades	College Mathematics/Science Grade Point Averages: 0.00 - 1.00	2.00 - 4.00	Total (per cent)
1.00 - 3.50	76	14	90 (56.9)
3.51 - 4.00	26	42	68 (43.1)
Total (per cent)	102 (64.6)	56 (35.4)	158 (100.0)

TABLE 2

The Frequency of Students' High School Science Grades and College Mathematics/Science Grade Point Averages

High School Science Grade	College Mathematics/Science Grade Point Average: 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
1.00 - 2.75	16	12	2	30 (20.3)
2.76 - 3.33	19	16	10	45 (30.4)
3.34	11	21	41	73 (49.3)
Total (per cent)	46 (31.1)	49 (33.1)	53 (35.8)	148 (100.0)

TABLE 3

The Frequency Distribution of Students' High School Rank and College Mathematics/Science Grade Point Averages

High School Rank	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Top 3%	15	10	23	48 (39.7)
4% - 10%	15	14	10	39 (32.2)
Other 90%	14	14	6	34 (28.1)
Total (per cent)	44 (36.4)	38 (31.4)	39 (32.2)	121 (100.0)

TABLE 4

The Frequency Distribution of Students' SAT-Mathematics Scores and College Mathematics/Science Grade Point Averages

SAT-Math. Scores	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
200 - 430	16	15	6	37 (23.6)
440 - 530	14	21	15	50 (31.8)
540 - 800	17	22	31	70 (44.6)
Total	47	58	52	157 (100.0)

TABLE 5

The Distribution of Students' College Mathematics/Science Grade Point Averages By Racial/Ethnic Composition of the High School Student Body

H.S. Racial/Ethnic Composition	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Exclusively or Predominantly Minority	32	30	34	96 (40.3)
About 50/50	22	16	13	51 (21.4)
Predominantly Non-Minority	27	30	34	91 (38.3)
Total (per cent)	81 (34.0)	76 (31.9)	81 (34.0)	238 (100.0)

TABLE 6

The Frequency Distribution of Students' High School Mathematics Preparation, Race/Ethnicity of High School Student Body and College Mathematics/Science Grade Point Averages

Race/Ethnicity	High School Math.	College Math./Science GPA			Total
		000 - 1.59	1.60 - 1.99	2.00 - 4.00	
Minority H.S.	Less than Calculus	7	15	15	37
	Calculus	14	4	7	25
Integrated H.S.	Less than Calculus	6		2	12
	Calculus	5	10	6	21
Predominantly White H.S.	Less than Calculus	12	6	8	26
	Calculus	7	12	18	37
Total (percent)		51 (32.3)	51 (32.3)	56 (35.4)	158 (100.0)

TABLE 7

The Frequency Distribution of Pre-Engineering Participants and Non-Participants By Racial Composition of the High School Student Body

Race/Ethnicity of High School	Pre-Engineering Participation		Total (per cent)
	YES	NO	
Minority	54	39	93 (41.2)
Non-Minority	47	86	133 (58.8)
Total (per cent)	101 (44.7)	125 (55.3)	226 (100.0)

TABLE 8

The Frequency Distribution of Students' Participation in a Pre-Engineering Program and College Mathematics/Science Grade Point Averages

Participation in a Pre-Engineering Program	College Mathematics/Science Grade Point Averages		
	Less than 2.00	2.00 or Above	
Yes	56	45	101 (44.7)
No	93	32	125 (55.3)
Total (per cent)	149 (65.9)	77 (34.1)	226 (100.0)

TABLE 9

The Distribution of Students' College Mathematics/Science Grade Point Averages By Race/Ethnicity

Race/Ethnicity	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Black	35	[illegible]	23	102 (56.0)
Hispanic	28	[illegible]	31	80 (44.0)
Total (per cent)	[illegible] (34.6)	[illegible]	54 (29.7)	182 (100.0)

TABLE 10

The Distribution of Students' College Mathematics/Science Grade Point Averages By Gender

Gender	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Male	48	48	53	149 (73.0)
Female	20	22	13	55 (26.9)
Total (per cent)	68 (33.3)	70 (34.3)	66 (32.4)	204 (100.0)

TABLE 11

The Frequency Distribution of Students' Selection of the Aspect of Engineering Most Appealing to Them and the College Mathematics/Science Grade Point Average

	College Mathematics/Science Grade Point Average		
Aspect of Engineering	0.00 - 1.99	2.00 - 4.00	Total (per cent)
Problem-Solving	19	19	38 (15.8)
Other Factors	140	63	203 (84.2)
Total (per cent)	159 (66.0)	82 (34.0)	241 (100.0)

TABLE 12

The Frequency Distribution of Students' Perceived Academic Ability and Their College Mathematics/Science Grade Point Averages

Perceived Academic Ability	College Mathematics/Science Grade Point Averages 0.00 - 1.99	2.00 - 4.00	Total (per cent)
Among The Strongest, Better Than Most	49	38	87 (38.5)
Average - Weak	100	39	139 (61.5)
Total (per cent)	149 (65.9)	77 (34.1)	226 (100.0)

TABLE 13

The Frequency of Students' Accurate Academic Self-Assessments and Mathematics/Science Grade Point Averages
(Based on High School Science Grades)

Assessment	Mathematics/Science Grade Point Point Averages			Total (per cent)
	0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	
Inflated	17	13	7	37 (25.2)
Poor	10	7	1	18 (12.2)
Accurate	19	28	45	92 (62.6)
Total (per cent)	46 (31.3)	48 (32.7)	53 (36.0)	147 (100.0)

TABLE 14

The Distribution of Students' Contact With the Minority Engineering Program By College Mathematics/Science Grade Point Average

Frequency of Program Contact	College Mathematics/Science Grade Point Average: 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Less Than Bi-Weekly	19	10	11	40 (37.0)
More Often	15	23	30	68 (63.0)
Total (per cent)	34 (31.5)	33 (30.6)	41 (37.9)	108 (100.0)

TABLE 15

The Distribution of Students' Hours Per Week Spent Studying By College Mathematics/Science Grade Point Average

Hours Studied	College Mathematics/Science Grade Point Average: 0.00 - 1.99	2.00 - 4.00	Total (per cent)
31 or More	16	17	33 (21.4)
Less Than 31	89	32	121 (78.6)
Total (per cent)	105 (68.2)	49 (31.8)	154 (100.0)

TABLE 16

The Frequency of Students' Accurate Academic Self-Assessments (Based on High School Mathematics Grades) and Mathematics/Science Grade Point Averages in College

Self-Assessment	High School Mathematics Grades			
	0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Inflated	20	12	4	36 (22.6)
Poor	13	7	1	21 (13.2)
Accurate or Under-assessed Average Students	20	33	49	102 (64.2)
Total (per cent)	53 (33.3)	52 (32.7)	54 (34.0)	159 (100.0)

TABLE 17

Frequency of Academic Success Among Blacks Who Study With Non-Minority Students

Frequency of Study With Non-Minority Students	College Math./Science Grade Point Average		Total (per cent)
	0.00 - 1.99	2.00 - 4.00	
Frequently	32	7	39 (73.6)
Seldom	7	7	14 (26.4)
Total	39	14	53 (100.0)

	Race/Ethnicity	College Math./Science GPA		
Majority		0.00 - 1.59	1.60 - 1.99	2.00 - 4.00
	Other	1	3	6
	Black	13	19	7
1 - 2	Mex.-Amer. / Puerto-Rican	3	7	10
	Other	1	2	2
	Black	4	3	7
3 - 5	Mex.-Amer. / Puerto-Rican	6	4	7

TABLE 18

ncy Distribution of Students' Attendance at Meetings of the Minority Engineering
udent Organizations and College Mathematics/Science Grade Point Averages

	College Mathematics/Science Grade Point Averages			
Attendance Level	0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Very Frequently or Frequently	22	30	18	70 (44.6)
Sometimes	13	21	19	53 (33.8)
Seldom or Never	12	7	15	34 (21.6)
Total (per cent)	47 (30.0)	58 (36.9)	52 (33.1)	157 (100.0)

TABLE 19

The Frequency Distribution of Students' Participation in High School Science Fairs/Mathematics Competitions and College Mathematics/Science Grade Point Averages

	College Math./Science Grade Point Averages			
Science Fair	0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Yes	33	29	27	89 (37.9)
No	49	49	48	146 (62.1)
Total (per cent)	82 (34.9)	78 (33.1)	75 (32.0)	235 (100.0)

TABLE 20

The Frequency Distribution of Students' High School Science Preparation and College Mathematics/Science Grade Point Averages

High School Science Preparation	College Mathematics/Science Grade Point Averages: 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Both Chemistry and Physics	22	29	30	81 (50.3)
Less Preparation	30	22	28	80 (49.7)
Total (per cent)	52 (32.3)	51 (31.7)	58 (36.0)	161 (100.0)

TABLE 21

The Frequency Distribution of Students' College Mathematics/Science Grade Point Averages By Their Degree of Active Involvement in the Minority Engineering Student Organization

Involvement in Engineering Student Organization	College Mathematics/Science Grade Point Averages 0.00 - 1.59	1.60 - 1.99	2.00 - 4.00	Total (per cent)
Very Much, Much	14	16	16	46 (29.3)
Some	10	17	8	35 (22.3)
Very Little, None	21	25	30	76 (48.4)
Total (per cent)	45 (28.7)	58 (36.9)	54 (34.4)	157 (100.0)