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Predicting Success in Mathematics for Underprepared Community College Students

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PREDICTING SUCCESS IN MATHEMATICS FOR
UNDERPREPARED COMMUNITY COLLEGE STUDENTS

by

Nancy Hoffius Taylor

A Dissertation
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
Degree of Doctor of Education

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Nancy Hoffius Taylor
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CHAPTER I

INTRODUCTION

Introduction to the Problem

The open door policy which characterizes today's community college is its greatest asset and its greatest liability. This policy is the cornerstone of the community college philosophy and is the primary characteristic that distinguishes this segment of higher education from the four-year colleges and universities.

The community college is a newcomer to the post-secondary educational scene -- it began in the 1800's and expanded in number soon after the turn of the century (Glaezer, 1963). Community colleges were created to fulfill society's demand for readily available and accessible college education for all United States citizens. The open door policy of most community colleges assumes that all U.S. adults should have the opportunity for post-secondary education. It also assumes that people taking advantage of this opportunity will benefit. The open door policy has brought to college a wide spectrum of people who in the past never dreamed of obtaining a college education. Previously, higher education had been the birth-right of only one segment of our citizenry -- the upper-class, white elite. During the last quarter-century society's concern with extending higher education to the masses has changed the student population to one including both sexes, all socioeconomic...
classes, and, most recently, a variety of disadvantaged minority groups (Ruskin, 1976). Although four-year colleges and universities have experienced a change in the student population and profile since World War II, the community colleges have been, and still are, the segment of higher education towards which the disadvantaged, minority, part-time or older students gravitate (Trend & Medsker, 1968). These students are often termed non-traditional (Blocker, 1965). The open door beckons; it convinces them that a college education is available and attainable, and that their desire for more education may become a reality. In this context the attempt to open higher education to all can be the greatest asset of the community college.

To convince the non-traditional group that higher education is accessible to them, the community college must assume the responsibility of providing education for the divergent population to whom they have so vigorously offered the American Dream of educational achievement. Jennings (1970) suggests that matching its pretensions with performance is the mission of the community college.

The problem to be resolved -- how could information be obtained that would predict student achievement with a minimum of testing and what type of test should be used?

Our educational systems are based on a traditional model which was designed to fit a relatively homogeneous group of students. Problems created by the heterogeneity of the non-traditional students are great. Students enroll in the community college with the expectation that their manifold needs will be met. When those needs are not met, a large number of students drop out. The tendency of the
open door to become the revolving door is the greatest liability of the community college and an area in need of research. Once the students with divergent expectations are enrolled, it becomes the educational and moral responsibility of the institution to provide the educational services advertised. How can this be done?

First, the institution must create and provide a learning situation that will minimize failure. The community college goal is often defined as helping students to become the very best that is within their range of abilities. Rationales have been offered to explain why many students will not succeed at college work; to explain that the open door means only an accessible opportunity to attempt to succeed and to explain that the college has fulfilled its obligation by making the opportunity available. Educators holding this view argue that the community college attrition rate is proof that "...the students were not college material." (Roueche, 1972, P. 10). Acceptance of this reasoning escalates the revolving door syndrome.

Second, at the outset of a course, students should be made aware of their predicted chances for successful completion of the course. Commitment to academic success must be an informed commitment. This is particularly essential for the insecure, non-traditional student who has committed time, effort, money and ego on an uncharted course.

Nearly every student planning to go to college is concerned about how well he will do once he gets there. This concern relates not only to the grades that he is likely to receive, but also to his chances of staying in college through graduation. (Astin, 1971, P. 3).
For the purposes of this study it was assumed that community colleges with an open admissions policy have a commitment to diagnose and inform students of their probable success in a course. Further, it was assumed that such colleges should attempt to insure that the institution provides instructional activities which enable the students to fulfill their selected educational goals. This apparent need for diagnosis, however, comes in conflict with the open door policy.

In order to avoid discouraging potential students, community college admission requirements are minimal. Enrollment consists merely of a form-signing ceremony and of specifying which classes a student would like to take. Entrance tests are not required; often a transcript of past high school achievement is not necessary. Credentials, when they are furnished, are often too old to be useful. Counseling services to assist enrollees in making course selections are available, but students are often not aware of these services, or do not choose to take advantage of them. Students arrive for the first class meeting with high expectations, but with little knowledge of their chances for successful completion of a class. After admission, most community colleges allow only minimal testing of students who are actually enrolled, and thus have made some type of commitment toward attempting college level work. It becomes the instructor's responsibility to teach this divergent group of individuals.

In an effort to reach each individual, different teaching strategies have been attempted on what might be termed a shotgun basis. Traditional and familiar lecture-discussion methods of the past continue to be the most prevalent teaching methodologies.
Lindberg (1976) found that 68 percent of all college preparatory mathematics classes were taught using the lecture-discussion format. Many teaching innovations have been reported in the literature. Self-paced behavioral systems approaches to individualized instruction appear to be successful in teaching a diverse heterogeneous group (Kulik, Kulik & Smith, 1976). Tutorial, flexibly-paced instruction, and audio-tutorial mastery learning instructional strategies have been implemented with good results (Lindberg, 1976). Research reveals different levels of success with different teaching methodologies, but is inconclusive at best. Each method has its failures; no single method is the optimal strategy for all individuals.

Past studies have concluded that past high school grade point average (HSGPA) or class rank (HSR) can predict future academic success (Astin, 1971), but this information is often not readily available to the instructor or counselor who must design a program of study for each community college student. Extensive testing, which would provide an abundance of information on each student, is not presently economically feasible and is in direct conflict with the open door policy as translated into rules and procedures.

Tests administered after admission but before enrollment to ascertain the students' academic level are not acceptable since it is believed that this might discourage a person from attending the community college. The non-traditional group of students, the group probably most in need of proper class placement, is perceived to be the group especially sensitive to testing (Losak, 1973).
Too much attention has been given to academic achievement and intelligence as indicators or predictors of student success...the 'scholastic aptitude' that is being measured by these tests is the rate of learning rather than the capacity for learning. (Roueche, 1972, P. 8).

Therefore, achievement, aptitude or IQ tests were not considered as predictor variables in this study.

Attitude tests are believed to be non-threatening to students and seem to be acceptable to the community college situation. They seem also to be acceptable measures for predicting success. In a review of the recent research on attitude towards mathematics, Aiken found; "When attitude scores are used as predictors of achievement in mathematics, a low but significant positive correlation is usually found." (Aiken, 1976, P. 296). Neale observes that, despite substantial differences in instruments and populations, evidence from a variety of studies indicates a remarkably constant correlation -- consistently placing the values in the $r = .20$ to $.40$ range -- between self-reported attitude towards mathematics and standardized mathematics achievement test scores (Neale, 1969, P. 634).

Attitude measure combined with other information readily available at the community college might increase the strength of the positive correlation. With this in mind, the following study was done to determine the effectiveness with which attitude scores can be combined with other limited information to predict achievement and success in mathematics courses designed for underprepared students in a community college.

Given the recent trend, it might be speculated that a consistently
increasing proportion of future college student-bodies will be under-prepared thus continuing or increasing the problems faced today by the community college as they attempt to meet the needs of such students. A decline in the traditional college-age population coupled with the trend of a decreasing proportion of high school graduating classes to attend college has led to the forecast that the non-traditional student population is the potential growth segment for all levels of higher education (Roueche & Kirk, 1973).

The Population

The population used for this study was the underprepared mathematics students at Lake Michigan College. This subgroup of a community college population was chosen since it appeared to include a large proportion of non-traditional students. It was assumed that the more traditional students, those with a long standing expectation of attending college, would have enrolled and successfully completed a college preparatory high school mathematics program; one with at least a basic algebra requirement. The non-traditional students would tend to have taken a more general high school program; one that excluded all but the state-required one year of general mathematics.

Independent Variables

At the time of this study, criterion referenced screening tests were given at the beginning of each mathematics course below the calculus level at Lake Michigan College to determine the students' proficiency level. These tests were developed at Lake Michigan College.
and were used only as a crude screen to identify those students with obvious mathematical deficiencies. The tests' ability to predict learning achievement or final grade had never been determined.

Each student who registered for one or more classes at Lake Michigan College was required to complete a registration form. Data that could be collected from this form for purposes of this study was limited to race, age, sex and scholarship or grant status. An optional section was included on the form dealing with family background and reasons for attending this particular college.

For the purposes of this study it was necessary to identify potentially predictive variables which were readily available, easily measured, economically feasible and non-threatening to students at the community college. The study was intended to be action research, based on the current findings and techniques developed through previous research. The literature suggested that predictive equations generated separately by age (Lunnenborg, et al., 1974; Young, 1977), race (Cleary, 1968; Silverman, et al., 1976), and sex (Fenneman, 1974; Gross, et al., 1974) could determine a larger proportion of overall learning achievement for each student than those equations generated for an entire class. Further, by considering subgroups of the underprepared student population, the heterogeniety of the group could be minimized. On the other hand, to single out particular subgroups could be viewed as being too selective. To this author it seemed irresponsible to ignore the research findings and deal only with the total group since that methodology could lead to an inability to develop the most accurate predictive equations. It seemed reasonable
that if the goal of the community college was to help each student develop to his full potential, then all the tools currently available should be used.

Society is a dynamic system in a constant state of change. Racial/ethnic minority groups, women and older students are relatively new to higher education. As these groups increasingly become assimilated into the college population they will no longer be identifiable as special subgroups. Separate regression analyses will no longer be necessary. Other independent variables will be appropriate at that time.

Dependent Variable

For the purposes of this study success, the dependent variable, was defined in the traditional sense, as receiving a grade of C or better. It is understood that success may have many meanings. This deliberately restrictive definition of success was chosen because it is quantifiable, relates directly to the education process, and has wide acceptance.

Purpose of the Study

This research dealt with the development of a model to predict success in the community college. Though the independent variables will be different for each community college and for each period of time, the methodology utilized for this study should have wide application.
The purpose of this study was to determine if success as measured by learning achievement in two levels of mathematics classes for underprepared students at Lake Michigan College could be predicted by a combination of a measure of attitude toward mathematics and criterion referenced screening test scores. In addition, demographic information such as sex, age and race, was analyzed as possible predictors of success. A separate analysis of attitudinal change using pre- and post-semester measures was computed. The basic questions to be answered by this research were:

1) Can a criterion referenced test score, an attitude toward mathematics measure, and demographic data be used to predict academic achievement for students enrolled in Basic Mathematics or Intermediate Algebra at Lake Michigan College?

2) Is the predictability at least as accurate as the predictability achieved in the past research studies; does it account for the same amount of variance?

3) Will these prediction equations generated be valid when applied to a similar group of underprepared mathematics students?

4) Is there an interaction effect between race, sex, or age and attitude on academic achievement?

5) If there is an interaction effect, is there a difference in predictability associated with race, sex or age?

6) Do underprepared mathematics students experience an attitude change during the semester?

7) Is change in attitude related to academic achievement?

8) Do underprepared mathematics students possess the same demographic characteristics as the total school population?

9) Are the demographic characteristics different between successful and nonsuccessful underprepared mathematics students?
Significance of the Study

This study is significant because it is related to three critical problems in the community college -- attrition rate, cost-effectiveness and accountability. Findings of this study may lead to the development of a tool to appraise community college students of the probable chances for successful completion of a mathematics class and assist in the correct placement in a class where the student will have a realistic chance of success. Proper placement in the correct level class should lead to successful completion of that class, less financial expenditure by students and more consistent progress toward their educational goals. More effective utilization of faculty and a consequent reduction of financial losses to the institution by reducing the attrition rate should be an additional result. During the fall semester, 1977, twenty-four percent of the students attending Lake Michigan College could be classified as grossly non-successful -- receiving a grade below D. Any effort to reduce this percentage seemed to be justified and worthy of consideration.

Generally attrition rate is directly related to cost-effectiveness at the community college. Identification of predicted successful students also yields identification of the potentially non-successful student, or those most likely to become drop-outs (Cross, 1971). Time is a finite quantity. Teaching time can be used most cost-effectively by concentrating on those students who have problems and need help. The ability to predict the potentially non-successful students and suggest to them placement in the proper level mathematics class can lead to a cost-effective use of educational resources.
The large attrition rate for underprepared students has been a matter of concern and an unacceptable situation. To have each student who enrolls in a course successfully complete the course is cost-effective. Identification of a problem is the first step in the solution of the problem. More effective placement can lead to greater student success and self-satisfaction and, thereby, yield a higher return on human and social resources. Optimal use of all resources is cost-effective.

Attrition rate and cost-effectiveness are two inter-related and yet independent parts of the broader issue of educational accountability. The public is acutely aware of their rights to quality education and the increasingly visible shortcomings of the system because of recent publicity concerning consumers' rights, legislative insistence on accountability and wide dissemination of information regarding the failings of the U. S. educational system. Among the effects of this new awareness are recent lawsuits charging "educational malpractice." (Dunn, Dunn & Price, 1977, P. 468). While the court actions have thus far been successfully defended by the sued parties, the atmosphere of pressure created by the litigation has made accountability a critical issue in the community college. The high attrition rate of students who enroll in the community college has raised serious questions concerning the responsibility of the instruction to increase the probability of success for its students. The ability to inform students of their predicted chances for success in a community college could lead to great accountability for the community college.
Underprepared students pose a particular problem in the area of student accountability; this is an especially critical problem for the community college. Monroe (1972) has observed that the majority of underprepared students perform at the 15th percentile or below on standardized tests. On some community college campuses this group may be as large as one-third of the entering freshman class. The members of this group, in general, have not had the successful previous educational experiences of their more traditional peers. They are familiar with failure. Roueche and Hurlbert (1968) point out that the underprepared students' aspirations are often not realistic; their aspirations are so high that they invite failure. Many underprepared students have learned through past educational experience to adopt a self-defeating behavior. For them it is easier to rationalize failure to achieve when their goals are unrealistically high; greater personal risk in involved in setting realistic goals (Roueche & Mink, 1976). As these students enter the community college open door, this failure-prone behavior must not be reinforced by the community college. The students should be shown how to make the system work for them. For example, community college catalogs often state that a specific course or proficiency is the prerequisite for class enrollment. This catalog statement, however, is only advisory. Students may voluntarily enroll for courses at any level. The freedom given to the students by open admissions places a great deal of responsibility on them to choose realistically. It is as important for the student to be accountable as it is for the institution.
This study dealt with the underprepared mathematics students at Lake Michigan College. Basic mathematical proficiency is one of the necessary keys for entrance to most technical or professional fields. College-bound students are aware of this fact and have kept their options open by taking the necessary mathematics classes in high school. Non-traditional students are more likely to have restricted their mathematical exposure. Their voluntary enrollment in a community college mathematics class for underprepared students can be viewed as a commitment to re-open their options and join the college mainstream. Prediction of their success will make their commitment an informed one. The ability to be able to inform students of their chances for successful completion of a community college course should help to establish realistic student goals, lead to informed commitment on the students' part and, thus, make them active participants in the educational process.

Limitations of the Study

This study was limited to a sub-population at Lake Michigan College. Glaezer (1968) and Roueche (1972), among others, state that each community college is, ideally, a reflection of the educational goals of its specific community. The methodology utilized for the study was problem-solving research. It is recognized that each institution is different. Although the predictive equations generated by this study are restricted to one particular population, the process developed by this research should be applicable to many other institutions and populations.
This study was specifically confined to a population of under-prepared community college students. Results of the regression analyses relative to these students may not be applicable to other populations of students. However, as has been mentioned previously, all levels of higher education can expect an increase in the number of non-traditional students in the 1980's and consequently, are and/or will be faced with accommodating underprepared students. This study may be of value to such institutions.

This study was limited to the subject area of mathematics. Mathematics is a precisely defined area of study, unencumbered by the ethnic bias and value judgments that are so prevalent in the social sciences. The results of this study may not be valid for other subject areas.

The reliability and validity of the criterion referenced screening tests used as one of the independent variables in this study, have not been determined. As Popham and Husek in their article, Implications of Criterion-Referenced Measurement, observe "The classical procedures (for determining reliability and validity of criterion referenced tests) are not appropriate." (Popham & Husek, 1969, P. 6).

This study did not compare the predictive ability of its independent variables against high school grade point average, class rank or standardized test scores. That data was simply not available for all underprepared students at the community college.

Research has suggested many other independent variables that may account for successful completion of a class. Student motivation, teaching methodology, personality characteristics of students and
teachers are only a few. This study was designed to use only
information readily available to the instructor or counselor;
information that could be obtained with a minimal disruption of the
everyday procedures and rules now in effect at Lake Michigan College.

Need for the Study

There is a need for this type of practical research. Thousands
of studies have been conducted attempting to predict student success
(Astin, 1971). The majority of these studies use as predictor
variables data that is not readily or practically available to the
average community college instructor. Very little research has been
done in the area of underprepared community college students (Roueche
& Kirk, 1973). The results of these studies are read with interest,
but are rarely useful. If research findings are to have an impact,
they must be implemented; research findings are often isolated from
the classroom. Every effort was made in the design of this study to
fit the study into the existing educational setting rather than
manipulate the educational setting so as to fit the research design.
A model design for predicting success based on readily available
information that can easily be used by the community college
instructor in the classroom has a good chance of being implemented
and, thus, of having an impact on the educational institution and the
community college student.
CHAPTER II

REVIEW OF SELECTED RELATED LITERATURE

Prediction Studies

Literally thousands of predictive studies have been done in the past (Astin, 1971), however, research on remedial programs in the open door community college is virtually nonexistent (Roueche, 1968). Prediction of academic success (as measured by grade point average) generally has been used by colleges to assist in better selection procedures in admissions. The role of prediction studies in the community college is quite different.

The community college has been called the People's college -- the last ditch effort for some, the hope of further education for many of the newer type of college students (Roueche & Kirk, 1973). It has an open door admission; no admission requirements other than that the student be an adult or have a high school diploma. In many cases even these minimal admission standards are not enforced or are non-existent. If students are not required or even expected to take admission tests, if high school records are not available and furnished to the community college, how can the institution determine who will succeed and who will not? The problem could be answered easily -- don't do anything. This is exactly what has been done; students enter, students fail, students leave. The attrition rate in the community college is huge (Stein, 1973). The open door is often a revolving door.

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One solution to the revolving door is suggested by O'Connell (1961):

The answer lies not in abolishing the open door, but rather in modifying it...Students with a negative prognosis should be counseled into areas in keeping with their talents. (P. 12).

Open-door two-year colleges confronted by large freshman classes with diverse educational achievement required predictive information to assist in placement. (The American College Testing Program, 1969, P. 103).

Admissions, guidance or placement needs can all be served by prediction studies. Lavin (1965) suggests another use:

Particularly, predictive models can be useful not only for the traditional tasks such as admissions, but also as a basis for modifying organizational structure, thus aiding in attainment of educational goals. (P. 170).

If success could be predicted 100 percent of the time, accountability would not be the issue it is today. Predicted non-successful students could be studied by traits that lead to their unsuccessful categorization, special programs could be designed to remediate the problems and, after a period of re-training, allow these students to be classified as successful. Everyone who began college would finish.

This is not an ideal world -- teaching technology is imprecise, testing is not accurate, students have many characteristics that confound their success rate. Prediction studies have never accounted for all the variance in students' grades, yet the partial knowledge gained from these studies can be of use in identification of problem areas, especially in the community college.
Research design

The most used research designs in prediction studies are those of correlation and regression. One or more predictors are used to approximate one or more criteria. Fishman and Pasanella (1960) classified predictors and criteria according to whether they deal with "intellective characteristics (aptitude-achievement test scores or course marks) or nonintellective characteristics (personality, motivational and attitudinal measures) of individuals." (P. 298).

In a survey of 580 predictive studies they reported: 70 percent of the studies used intellective measures for both criteria and predictors, two percent used nonintellective measures for both. Of these 580 studies, 94 percent used intellective measures for the criteria; the remaining six percent used nonintellective measures either exclusively, four percent, or in part.

Criterion (dependent) variable

The usual criterion variable in predictive studies is a measure of academic success; in most cases, it is based upon student grades. These may be dichotomized into success (A, B, C) or non-success (D, E, F) or used as a grade point average (GPA). Time of completion of the required instructional objectives is often used as the criterion variable in the newer behavioral systems approach to instruction. The rate of attrition has been used, classifying students as drop-outs or persisters.

In their research Fishman and Pasanella considered two basic
types of predictive studies: 1) global prediction -- using the
criterion of overall or comprehensive academic excellence (usually
based on first-semester or first-year academic success) and 2)
differential prediction -- using specific success measured in specific
courses or curricula as the criterion. Goldman and Slaugher (1976)
have suggested that the correlation of predicted success to actual
success can be strengthened by the differential prediction model.

Independent variables

No matter what measures are used for the criterion variables, a
problem common to all correlation and regression studies is that of
selecting the independent variables. The number of predictor
variables had been restricted to one, two, or three before the
availability of modern computers. With the development of the
computer, the tools to use in multiple regression, discriminant analysis,
canonical correlation and even factor analysis are available to the edu­
cational researcher. Now, ten, twenty, or any number of variables
can be fed into the computer and complex statistical procedures can
be calculated in a short period of time. One study found in this
review used forty intellective predictor variables (Dahlke, 1974).
However, practical consideration must be given to the problem, time
and expense involved in administering tests to students involved in
the studies and to the handling of data. An indiscriminant inclusion
of independent variables may complicate the interpretation of results.
Standardized tests

Standardized academic testing on a nationwide scale occurs each winter as juniors and seniors in high school take the college entrance examinations. Astin (1971) in a comprehensive survey of 2300 American colleges including 38,681 students found the correlation (r) between these standardized tests and college GPA to be r = .35 and r = .43, respectively for men and women. The most commonly administered tests, the three major tests of academic ability are: 1) The Scholastic Aptitude Test (SAT) with its subscores of verbal (SAT-V) and mathematical or quantitative (SAT-M, SAT-Q) measures; 2) The American College Test (ACT); 3) National Merit Scholarship Qualifying Test (NMSQT). Arguments have raged over the years to determine which is a more accurate predictor of academic success. Astin (1971) found that the composite scores of these three tests (SAT, NMSQT & ACT) are highly intercorrelated with an average correlation of about .85. "For most practical purposes, the scores are interchangeable." (P. 20).

As colleges opened their doors to a still greater variety of ethnic and racial groups, discussion and debate prevailed on the credibility of the SAT, ACT and similar standardized tests to predict the success rate for these subgroups of college students.

High school grade point average (HSGPA) -- high school rank (HSR)

In order to contradict the bias charge leveled at standardized testing (Cleary, 1968), high school grade point average (HSGPA) was
considered as an adjunct or substitute predictor. The closer relationship of HSGPA and college grades is reflected in the correlations, $r = .51$ and $r = .52$ for men and women, respectively (Astin, 1971). The combination of HSGPA and a standardized test score to predict freshmen grades increases the multiple correlation -- $R = .51$ for males, $R = .55$ for females.

The variation in high school grading practices has been offered as a reason for the variance in prediction equations (Thomas & Stanley, 1969). High school rank (HSR) has been used as an additional measure of past academic achievement (Tatham & Tatham, 1974). High school rating factors have been used to account for the differential between grading practices in various schools (Hedges & Majer, 1976; McDonald & McPherson, 1975).

The fact must be kept in mind that standardized test scores, HSGPA and HSR, are all considered to be measures of the same trait -- past academic achievement. HSGPA is clearly the better predictor of freshmen GPA (Astin, 1971). Intellective predictors produce an average multiple correlation of $R = .55$ (Cohen & Guthrie, 1966). They have reached an asymptote of around $R = .50$ (Binder, et al., 1970). The best predictability of college success based on one or more of these intellective factors still is able to predict only 23 percent of the variability ($R^2 = .23$).

Nonintellective variables

The trend today is towards multiple predictors. Although studies have used intellective criterion variables and intellective predictor
variables, several have used multiple correlation techniques, combining intellective and nonintellective variables. According to Fishman and Pasanella (1960), when this was done, the gain in multiple correlation attributable to the nonintellective predictors was discouragingly small. "As we add various predictors to our basic one -- high school grades -- the correlations with college GPA get larger." (Astin, 1971, P. 12). This is shown in the table below.

<table>
<thead>
<tr>
<th>Predictor(s)</th>
<th>Correlation with Freshman GPA for Men (R)</th>
<th>Women (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. High School Grades</td>
<td>.51</td>
<td>.52</td>
</tr>
<tr>
<td>2. (1) + Aptitude Test Scores</td>
<td>.52</td>
<td>.55</td>
</tr>
<tr>
<td>3. (2) + College Selectivity</td>
<td>.54</td>
<td>.58</td>
</tr>
<tr>
<td>4. (3) + 13 Personal Characteristics</td>
<td>.59</td>
<td>.61</td>
</tr>
</tbody>
</table>

Cohen and Guthrie (1966) reason:

The improvement in prediction with the addition of nonintellective predictors has rarely exceeded .05...Since high school grades reflect the unique combination for each individual of intellective and nonintellective factors, it is not surprising that they remain the best predictor of college performance. (P. 89-90).

**Attitude.** Attitude may be defined as "indicating action, feeling, or mood" (Grove, 1971). This definition is very vague. Research studies often use motivation, personality factors, feelings of alienation and of anxiety, and even "mathophobia" as synonyms for attitudinal traits. It may be assumed that each of these factors is a component, contributing to, and thus forming an individual's attitude toward education and toward a particular area of study.
Aiken (1976) reviewed the research that had been done on attitude and other affective variables in learning mathematics. He suggests that the interrelationship and interdependence of attitude and achievement has been substantiated and that this knowledge points to new applications in educational practices.

Neale (1969) reviewed past empirical studies relating attitude and mathematics achievement. He found that, although these studies were of varied types and populations, they were consistent in finding a correlation in the $r = .20$ to $r = .40$ range. In a study of academic performance of disadvantaged students Trachtman (1975) found that the use of attitudinal variables effectively doubled the amount of variance accounted for by cognitive factors in a prediction equation (from 20 percent to 40 percent).

Socioeconomic. During the past decade increased emphasis has been given to equalizing educational opportunities and making post-secondary education accessible to all who desire to participate, regardless of financial status or past academic history (Fife & Leslie, 1976). The history of federal aid to individuals had its beginning with the passage of the Service-men's Readjustment Act of 1944, which authorized direct payment for education purposes to former servicemen under the G.I. Bill. National support for government subsidized post-secondary education was further expanded with the passage of the National Defense Education Act of 1958. Additional changes in federal policies regarding financial aid were incorporated into the Higher Education Act of 1965 which authorized the first federal program of non-repayable grants for low income students. The Education Amendment Act of 1972 made major
revisions in the Higher Education Act of 1965 and was aimed at equalizing educational opportunities. Most striking was the provision for the Basic Educational Opportunity Grants (BEOG).

The BEOG program is a source of financial aid that has been available since the beginning of the 1973-74 academic year. The purpose of the BEOG is to provide eligible students with a "floor" of financial aid to help defray the cost of post-secondary education (BEOG Handbook, 1975). Grants from $200 - $1,400 per academic year are available to all undergraduates attending approved colleges, universities, vocational, technical and career training schools. The dollar amount awarded is determined on an individual basis using a standardized formula: the criteria being financial need as determined by the applicant's financial statement, and the projected cost of tuition and room and board. The provision allowing grant money to be applied toward living expenses as well as tuition has served to minimize the financial obstacle to college attendance for many low-income students (Hansen & Lampman, 1974).

In addition to increased financial aid, the open door policy of the community college has made post-secondary education accessible to a more diverse section of the population. The community colleges are taking on a new dimension. No longer are the students a select group ...but are more representative of the total population -- mentally, socially, and economically (Roueche & Mink, 1976). Thus we see the emergence of a large number of non-traditional students at the community college level. The BEOG alone, or with a combination of other financial aid packages, has made post-secondary education feasible
for these students (Fife & Leslie, 1976). Socioeconomically, often educationally, disadvantaged minority students are increasingly gaining admission to college regardless of past academic achievement. The ability to predict academic performance of these non-traditional students is of a high priority if such programs are to provide them more than a brief and bitter academic trauma (Trachtman, 1975).

In a comparison of regularly admitted and disadvantaged freshmen at the University of Illinois, the correlation between first semester GPA based on HSR and SAT scores was significantly different for the two groups (Bowers, 1970). It was found that HSR and a number of English classes taken in high school could discriminate between successful and nonsuccessful college students in a special admissions program. Hedges and Majer (1976) found a multiple correlation of $R = .29$ when they compared the HSGPA, SAT score and an adjusted high school rank factor with the academic performance of a group of Educational Opportunity Program (EOP) students. Petry and Craft (1976) obtained a multiple correlation of $R = .49$ working with high-risk students. This high correlation was obtained not only using intellective variables, but attitudinal measures as well. Trachtman (1975) summarized:

The two traditional measures of cognitive function (reading, $r = .44$, and math, $r = .42$) were the best predictors of final grade. Yet, consonant with much of the related research, they account for only 20 percent of the total variance. The findings support the applicability and relevance of these basic cognitive components in the prediction of academic performance among minority students and, at the same time, underscore their relative inefficiency as sole predictor variables. (P. 327).
Race. The civil rights movement has led the drive for equal educational opportunity which is reflected in the increasingly varied racial make-up of college populations and in the large amount of research being reported on race as one component of a multiple prediction equation. "Differences between the races in their academic performance during the freshman year in college are entirely attributable to differences in ability and past performance, not to the effect of race per se." (Astin, 1971, P. 14).

Many have charged that the measurements used to predict academic success are biased. Cleary, in a 1968 study categorized a test as biased if the criterion score predicted from the common regression line is consistently too high or too low for members of the subgroup. Her study found that there was little evidence that the SAT is biased as a predictor of college grades. However, when either HSGPA or HSR was used in addition to the SAT as predictors, the degree of positive bias for the Negro students increased. Silverman and Barton (1976) confirmed these findings -- the combined use of ACT scores and HSR as predictors of academic success tended to overpredict for Blacks, accurately predict for Whites and underpredict for Jews. Thomas and Stanley (1969) and Dalton (1974), among others, have all explored the differential predictability for minority students. Allen (1976) found that SAT score was as good a predictor for Black/Chicano groups as it was for White groups, although the minority group correlation had a greater range (r = .16 to r = .55 for Whites, r = .06 to r = .51 for minority).
Age. With the current trend toward life-long education, the older students have become a more visible group. However, very little research appears to be devoted to age differences in higher education. This may be due to the fact that, until recently, the older students were such a minority that they were just ignored. "Increasingly, learning throughout life (continued learning) will be necessary for the largest proportion of the work force." (Bloom, 1968, P. 9).

Young (1977) compared the academic performance of welfare mothers over 25 and under 25 who were participating in a work incentive training program (WIN). The most striking finding was that older mothers performed significantly better than did younger mothers. Although 60 percent of the total group obtained average grades, the success rate for older women was much higher -- 71 percent vs. 45 percent.

Lunnenborg, et al. (1974) on the basis on nine intellective and nonintellective variables, compared a group of "over 35" college students with a group of students of normal college age. It was found that the median scores for the older students were higher for vocabulary and spelling and lower for the three quantitative tests. The test battery did a modest job of predicting GPA for the older students. The multiple correlations ranged from R = .32 to R = .47 for females and R = .22 to R = .65 for males. It was concluded that "any attempt to predict grades in a middle-aged college group should include background variables as well as tests of ability." (P. 220).

Price and Hikim (1976) used age as one of the variables to predict success in business classes. This choice of predictor was based on the reasoning that the cumulative GPA as a measure of college
performance is assumed to be a function of age, high school grades and college entrance test score. It was found that age correlated significantly with GPA adding \( r = .065 \) to the multiple correlation. The prediction equation accounted for 75 percent of the variance.

**Sex.** Women receiver higher grades in both high school and college. The academic performance of the female surpasses that of the male during their freshman year in college even when they are matched in terms of high school grades and aptitude scores. However, women are more likely to drop out after their freshman year in spite of their superior academic performance (Astin, 1971). It has been a widely circulated idea that males and females test differently and that females are more predictable than males when determining academic success (Lavin, 1965; Seashore, 1962). The majority of studies in this review confirm this fact.

In a study of overall GPA at ten colleges, Gross et al. (1974) found that using a prediction equation based on six predictor variables the multiple correlation for males ranged from \( R = .16 \) to \( R = .55 \) with a median of \( R = .43 \), while it ranged from \( R = .34 \) to \( R = .51 \) for females with a median of \( R = .49 \). Behr (1973) predicted Intermediate Algebra grades based on high school mathematics average, SAT-Q score and the Aikens attitude score and found a multiple correlation for males of \( R = .286 \), females \( R = .575 \).

Astin (1971) cautions that these sex differences are substantial for the brighter student, but virtually non-existent among the less able. He reasons:
Assuming that motivational factors account in part for sex differences, it follows that motivation makes a greater difference to the performance of highly able students than to the less able students...Such a conclusion implies...that any attempt to improve academic performance...is more likely to be successful among highly able students than among less able students. (P. 11).

The Community College

One of the most pressing challenges facing mathematics educators at the college level is to improve the instruction of undergraduate mathematics (Williams & Mick, 1976). This is particularly difficult for open admission colleges which are faced with a large number of low ability students.

The instituting of Open Admissions in the City University of New York has sharpened the focus of higher education upon remedial mathematics and the closely related question -- can basic skills unlearned in secondary school be acquired in college? At this particular institution over half the students screened were deficient in ninth grade mathematics. (Corn & Behr, 1975, P. 9).

The problem is compounded for the open door community college. The two-year college is plagued by rapid growth, by an incredible variety of students; ages, abilities and backgrounds, and by the relatively brief time that a student is present. No wonder that the attrition rate is 40 percent to 60 percent. The correct placement of a remedial student is crucial. To alleviate this attrition rate, the math department has the responsibility to inform and advise, preferably with the aid of examinations that it makes up and revises in view of its own courses and clientele (Stein, 1973).
Teaching methodology

Teaching methodology is changing at the community college. In a survey of community college mathematics programs, Carter (1975) concluded:

One obvious fact is that the lecture certainly is not always the primary means of instructing a math class. The overall trend was for instructors to use less lecture and more individualized instruction for the instruction of remedial classes than for non-remedial classes. (P. 16).

A nationwide survey of college preparatory mathematics programs (PMP) was conducted by Lindberg (1976) to determine just what changes are taking place in mathematics education. He noted that PMP have become a significant part of the instructional efforts of most math departments, including those of many major universities. It was found that 60 percent had made major instructional changes in the last six years, or were planning to make major changes. Most of this change was away from traditional approaches. New teaching strategies, often referred to as behavioral systems approaches, have begun to be the preferred model of instruction in remedial courses.

The ability to teach a diverse group of individuals on a one-to-one basis, with the help of audio-tutorial or programmed materials, is one of the appeals of the behavioral systems approach. A 1976 Review of Educational Research article (Robin, 1976) gives a complete overview of the many different methods of instruction subsumed under the behavioral systems approach. The Keller Plan, or Personalized System of Instruction (PSI), is one that has received wide implementation and research in recent years (Kulik, Kulik & Carmichael, 1974).
It may be that the individualized instructional system is particularly appealing since it contains the goals of identifying mathematical objectives in terms of specific behaviors and involving a requirement of mastery (Newman, et al., 1974). Mastery learning is based on the learning theories of Skinner (1954), Carroll (1963), and Bloom (1968). Traditionally, educational achievement has been viewed as a combination of two variables, learning and time. Time was held constant and the amount of learning that occurred within this time was defined as achievement. Student learning variability was great. Skinner, Carroll and Bloom offered a new theory. Basically, their theory is that almost all students can learn -- it is the time that it takes individuals to learn that should be variable -- the amount learned is held constant. This reciprocal translation of time/learning to redefine academic achievement is the core of newer educational systems.

One of the main goals of individualized programs is to maximize the opportunity for all students to learn at their own pace. Tests are used to place students at the correct level and to monitor their progress. It follows that these tests must be keyed to the instructional objectives (Popham & Husek, 1969).

**Criterion referenced vs. norm referenced tests**

Hambelton (1974) charges that there is a shortage of information on the new approaches to education. One reason for this shortage is that measurement requirements within the new instructional programs require new kinds of tests. These are criterion referenced tests which
are constructed and interpreted in ways quite different from the norm-referenced tests with which most practitioners in the field are more familiar. It is exactly the need for newer tests that creates problems in research.

Most of the standardized tests of achievement or intellectual ability -- such as the SAT, ACT, and NMSQT -- are classified as norm-referenced measures. Norm-referenced measures are those which are used to ascertain an individual's performance in relationship to the performance of other individuals on the same measuring device. The independent score's meaning is derived from comparison with other scores (Popham & Husek, 1969).

Criterion referenced measures have seen increasing use in the past few years in the classroom. These tests have been designed to provide the kind of test score information needed to make a variety of individual and programmatic decisions arising in objective based instructional programs (Hambleton, 1974). Broadly defined, a criterion referenced test is used to identify an individual's status in relationship to an established performance standard. The individual's score meaning derives from how well they have mastered the objectives. The meaning of norm-referenced tests comes from comparison against others -- criterion referenced tests are not dependent on comparison with other testees (Popham & Husek, 1968).

There is little doubt that achievement testing... will change in the future. The reason is simply that the demands being placed on achievement tests cannot be fulfilled by what we are currently doing. Signs pointing to the need for a new approach to achievement testing are found everywhere. One example is the current furor over criterion referenced
testing and the concommitant dissatisfaction with standardized tests. (Shoemaker, 1975, P. 128).

Walker (1974) in a discussion of standardized achievement tests states: "When new curricula have been compared with traditional approaches, the efforts have been hobbled by weakness in the tests and testing programs." (P. 147). Although criterion referenced tests have gained in use, norm-referenced tests are still the type used for district-wide evaluation and assessing the impact of an experimental program (Petrosko, 1978).

One reason for the furor mentioned above may be the necessary restructuring of the entrenched definition of reliability and validity measurements associated with testing. A test's worth in the past has been judged by procedures, many of which are statistical. Reliability and validity of norm-referenced tests depend on variance within scores. The ability to rank individuals is basic to the statistical interpretation of the scores. Each educator hopes that, at the end of a course, each student will have reached proficiency on all instructional objectives. If this were to occur, variability of scores would not exist. Although this has been an unrealistic expectation under past educational practices, with the trend toward behavioral systems of instruction with their proficiency learning component, mastery becomes a reality. Criterion referenced tests will need a new definition of reliability and validity. Reports are beginning to appear in the literature (Hambelton, 1974; Popham & Husek, 1969; Shoemaker, 1975).

The previous discussion on norm-referenced vs. criterion referenced tests has a particular bearing on research to be done in the area of
mathematics education. Romberg (1962) gave the following judgments:

"It is safe to generalize that, in most mathematics studies conducted during the 1960's, researchers used inappropriate or inadequate measuring devices to assess mathematics achievement." (P. 482).

Petrosko (1978) studied the quality of standardized tests overall and particularly the mathematics component of these tests and concluded that his analysis of tests from all areas of math confirmed the criticism leveled at them from many quarters.

Non-traditional, underprepared students

Standardized tests and HSGPA have been the most valid and consistent indicators of academic success, and therefore, the most often used independent variables in predictive studies. These measures are not readily available to the educator in an open door institution. Although the expectation is that college-bound students will go through the college entrance examination trauma during their high school years, community college students are often not drawn from the expected college-bound group.

In her study of "Higher education's newest student," Cross (1968) examined the characteristics of a new student appearing in increasing college enrollment:

He represents the American goal of universal higher education. He comes from the lower socio-economic levels, and he has less motivation for intellectual pursuits than the traditional college student. He is to be found, not in the well established four-year college, but in the emerging junior and community college. (P. 38).

Remedial, low ability, low achieving, underprepared, developmental,
high-risk, educationally disadvantaged, are a few of the most
commonly used terms which refer to a special group of community
college students. There is much confusion, controversy and disagree­
ment over the terms that are applied to this group. "Whether or not
one agrees with the euphemisms is really not of importance --
community junior colleges usually provide the same educational
programs for all students in the designated category." (Roueche,
1968, P. vii). Members of this group may be identified as those
students who suffer from one or more of the following characteristics:

1) Graduated from high school with a low C
   average or below,

2) Are severely deficient in basic skill,
   i.e., language and mathematics,

3) Have poor habits of study (and probably
   a poor place to study at home),

4) Are weakly motivated, lacking home encour­
   agement to continue in school,

5) Have unrealistic and ill-defined goals,

6) Represent homes with minimal cultural
   advantages and minimum standards of living,

7) Are the first of their family to attend
   college, hence have a minimum understanding
   of what college requires or what opportunities
   it offers.

Individualized instructional approaches are necessitated by the
underparalleled diversity in the contemporary two-year student body
(Roueche & Kirk, 1973).

Community college remedial research

The choosing of measurement instruments for a predictive study
involving non-traditional students creates many problems. Non-traditional students may be defined as the complement of the traditional college student population. A large segment may be underachievers; the standardized test floor creates problems for them (Thomas & Stanley, 1969). Minority groups may comprise a large proportion -- the test bias charge comes into play (Cleary, 1968).

One prolific writer on the community college and, especially, the underprepared community college student is Dr. John Roueche. His writings are replete with statements concerning the paucity of research on the remedial student. In 1968 Roueche stated: "Research on remedial programs at the community college is virtually nonexistent ... The programs are too recent in origin for a body of research to be available." (P. viii). In a 1973 update on remedial education, Roueche and Kirk again found that, although there have been surveys to ascertain the types of programs, the number of students enrolled in these programs and the nature of the services provided for non-traditional students, empirically based studies in the area of remedial education for community college students are still lacking. This review of the literature confirms that fact. Empirically based studies confined to remedial mathematics are particularly small in number. The literature dealing with the junior or community college is descriptive in nature -- detailing with what is being done, not how effectively it is being done. Skill oriented, performance based, competency learning, are all terms that are familiar to the trade industry. It is suggested that the learning methodology long accepted in technological training has just recently found its way into academe. Roueche
charges that, due to this lack of research on the effectiveness of remedial programs, institutions tend to implement programs and courses by trial and error.

Mathematics Predictive Studies

One study (Edwards, 1972) dealt with predicting success for remedial community college students. The population for his study was drawn from seven community colleges and was originally composed of 621 students. The number was reduced to 359 due to lack of complete data on each student.

The independent variables used were: 1) scores from the Comparative Guidance and Placement Battery (CGP), a) reading, b) sentences, c) mathematics and d) mathematics interest; 2) high school average; 3) number of class hours for which registered; 4) number of credit hours given in remedial mathematics; 5) attitude toward mathematics from the Dutton test; 6) work status while attending college; 7) sex. The criterion variable was a dichotomized score; success (A, B, C) and non-success (D, F, W).

A comparison of the means and standard deviation of males and females found the males scored significantly higher on the independent variables of reading, working status, math test and math interest; the females scored higher on high school average and sentences. The students classified as successful scored higher on all variables except work status. The multiple correlation for males was $R = .35$, for females $R = .42$.

The best prediction equation was found to be composed of five
variables: high school average, math test score, attitude toward math, sentences test score and math interest (R = .33). The CGP was administered to 119 of the subjects at the end of the semester to determine the learning achievement/standardized test relationship (r = .64). Edwards found that various cut-off points for success/non-success categorization gave varied percentages of correct prediction. The higher the level for passage, the greater the level of predictability (level .50 = 65 percent, . 55 = 69 percent, .60 = 71 percent, . 70 = 88 percent). He noted that, at the close of the semester, 57 percent of those that had originally been predicted as non-successful were still in need of remediation, while 47 percent of the predicted successful group needed further remediation.

Open door colleges do not require standardized admission tests. By selecting only those students who had volunteered this information, and excluding all others from the sample, the generalizability of Edwards' results can be questioned. The excluded students may not have taken admission tests because they did not plan to go on to college. Edwards may have excluded the majority of non-traditional students by limiting his sample.

Morgan (1970) studied the prediction of success in junior college mathematics. His sample was drawn from students enrolled in an open admissions community college, but was restricted to those who scored 15 or higher on the Cooperative Mathematics Test. By this action he excluded the remedial student.

The dependent variable was, again, dichotomized into success (A, B, C) and non-success (D, F, W). Fifty day school students
were selected as the population for the study — again the non-
traditional night student was excluded. Morgan states: "The
particular college under consideration has employed an 'open door'
policy regarding admissions. For this reason, entrance examinations
have not been used." The independent variables were: 1) the number
of years of academic high school mathematics; 2) the mean grade
point in high school mathematics; 3) score on Cooperative Mathematics
Test; 4) age, in months beyond the seventeenth birthday. The
independent variables contributed 25 percent, 27 percent, 34 percent,
14 percent, respectively, to the multiple R of .65.

Morgan found that the Cooperative Mathematics Test alone
accounted for 50 percent of the variance in classification on the
dependent variable while the multiple regression equation accounted
for 90 percent.

It is interesting to note that the two studies just reviewed
(Edward R = .33 for remedial math students, Morgan R = .65 for
regular community college math students) used students at different
levels of mathematical knowledge and skill. The multiple correlation
increases as the course hierarchy increases.

Corotto's (1963) study, the prediction of success in initial
college mathematics courses, used students in three levels of
freshman mathematics classes to compare the relative effectiveness of
standardized achievement test score; (ACE, American Counsel on
Education Psychological Examination for College Freshmen) and an
in-house mathematics screening test (MST) as predictors of success.
He also dichotomized grades, the dependent variable, into successful

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(A, B, C) and non-successful (D, F). The three courses (in increasing level of mathematical difficulty) were: 1) Math 030 -- a remedial math class; 2) Math 153 -- prerequisite Math 030; and 3) Math 131 -- prerequisite two years of high school algebra and approval of department chairman.

The biserial correlations for the ACE score and final grade in each class were .28, .08 and .16 respectively. The MST biserial correlations were .14, .42, and .40 respectively. On the basis of these findings it could be concluded that remedial math success is best predicted by a standardized achievement test while higher level math class success is best predicted by in-house screening tests.

Reasons for Corotto's results may lie in the fact that the same in-house screening test was given to each level of math class. The criticism of a "floor" that has been leveled at standardized achievement tests (Thomas & Stanley, 1969) may be magnified by the use of an in-house test across mathematical levels. The in-house test may have a higher "floor" than the standardized test. Different results might have occurred if separate screening tests were developed for each level -- tests keyed to the ability of each student population.

Wick (1965) studied factors associated with success in first year college mathematics. The subjects for this study were 1692 students in six colleges. The population was restricted to "non-remedial, non-terminal" mathematics classes. The study was conducted to determine the effect of past mathematical training, experimental or traditional mode of instruction on final grades in three levels of college mathematics (1 -- college algebra, 2 -- college algebra and
trig., 3 — calculus and analytical geometry). The independent variables used were: 1) math average, grades 10-12; 2) math average, grades 11-12; 3) math average, grade 12; 4) ratio of A's, grade 12; 5) high school rank; 6) scholastic aptitude test score; 7) math aptitude test score; 8) mathematics placement test score. The correlation between each of these independent variables and the dependent variable ranged from $r = .34$ to $r = .59$, median $r = .53$ for college algebra; $r = .26$ to $r = .44$, median $r = .38$ for college algebra and trig.; $r = .24$ to $r = .46$, median $r = .39$ for calculus and analytical geometry.

The four best predictor variables were 1) math average over grades 10 to 12; 2) math aptitude test score; 3) high school rank; 4) general scholastic aptitude score. The range for the multiple correlations were $R = .30$ to $R = .75$ with a median of $R = .64$. No significant difference was found between the groups based on the past method of mathematical instruction.

The population in this sample excluded remedial, lower-level mathematics students as did the Morgan study previously discussed. Although different predictor variables were used in each study, it is interesting to note the constancy of the multiple correlation; Morgan $R = .65$, Wick $R = .64$.

The trend in mathematics instructional methodology seems to be toward individualized instruction. The question arises — do the factors that predict success in a traditional model of instruction contribute to success in the same manner under a behavioral systems instructional model? The Keller plan, or Personalized System of...
Instruction (PSI), is an adaptation of one form of behavioral system (Keller, 1968). It embodies self-paced, individualized learning and incorporates the mastery learning models of Bloom and Carroll. In PSI the definition of success is based on learning achievement being held constant, each student must reach proficiency level (usually 80-90 percent) before going on to the next unit. The time allowed to reach mastery of the instructional objective varies. The definition of success, then, is how much time it takes each individual to reach proficiency level.

Dahlke (1974) studied the best predictors of success in an individualized course in arithmetic at a community college. He observed that allowing a student to determine his time of completion is a key feature in a self-paced course; yet there is little knowledge of the variables that will predict this. Dahlke defined successful students as those who completed the assigned units in one and one-half semesters. All other students were classified as unsuccessful. The population for this study was 113 students enrolled in Math 031 and Math 092, both remedial mathematics classes at Washtenaw Community College. Both intellective and non-intellective independent variables were used. Through step-wise discriminant analysis it was found that the four best predictors were: 1) pre-course arithmetic computation score; 2) reason for enrolling — review; 3) age; 4) reason for enrolling — prerequisite.

The Newman, et al. (1974) study concerned initial attitude differences among successful, procrastinating and withdrawal students in a PSI statistics class at two colleges. At the beginning of the
class 229 students were given attitude tests. The basic premise investigated in this study was whether or not the attitudes of students identified at the end of the course as either procrastinator (studied work intermittently, but increased rate of production up to the last day) or withdrawals (did not complete assigned work in time allowed) were reliably distinguishable from the successful students (completed all work at a consistent pace from the outset of the course). By means of a factor analysis, Newman concluded that the students with negative attitudes were more likely to be classified as withdrawals or procrastinators.

In a seminal study Aiken and Dreger (1961) studied the effects of attitude on performance in mathematics. Due to the result of a pre-test, separate analysis was done for the 60 males and 67 females enrolled in freshman mathematics at a southeastern college. The courses covered in this study were general mathematics, intermediate algebra and college algebra; although "Most of the analysis was carried out on the five sections of general mathematics." (P. 20). The criterion variable was final grade in the class. The final regression analysis was based on the independent variables of: 1) high school average; 2) Differential Aptitude Test (DAT) verbal reasoning score; 3) DAT numerical ability score, and 4) a math attitude score. The multiple correlations were found to be: males $R = .67$, and females $R = .63$. By applying the equation determined from the general mathematics students to the algebra students, a correlation of $r = .69$, males; and $r = .65$, females, was found based on predicted grades against actual grades. Aiken and Dreger concluded that mathematics attitudes...
are apparently related to intellective factors and to achievement in mathematics.

These findings were confirmed in a study of the relationship of attitude, aptitude and achievement (Behr, 1973) using 150 males and 173 females enrolled in a higher level college mathematics class. The criteria for being included in the sample was that each subject had successfully completed intermediate algebra and had an overall high school average between 75 percent and 85 percent. High school mathematics average, SAT-Q score and a measurement on the Aiken's Attitude Toward Mathematics Opinionaire were gathered. The correlations between these three independent variables and the dependent variable, final grade, were calculated based on sex; females R = .575; males, R = .286. The study concludes that there is a difference in attitude at the beginning of a class based on sex and that the correlation of attitude toward mathematics with aptitude and achievement in mathematics is significantly higher for females than for males. An interaction effect is suggested by these findings.

Jackson (1974) concluded that there was a significant positive correlation between the attitude toward mathematics of a group of disadvantaged students and their achievement in elementary mathematics courses at the college level. Wilson (1973) found this same interaction effect between attitude, aptitude and achievement in a study of 206 students enrolled in a mathematics course for elementary teachers. He went further and explored the relationship of pre-course and post-course attitude on final grade. He found that there is a significant relationship between pre- and post-course attitude, r = .861, and that
attitude did not change significantly during the course.

Neale (1969) reviewed the findings of several past studies on the relationship of attitude and achievement in mathematics and concluded that, although the population and procedures were markedly different, the results were consistently in the \( r = .20 \) to \( r = .40 \) range. He suggests, however, that these results could be viewed in two ways -- attitude may cause learning or a positive learning experience may cause a positive attitude. There is a reciprocal arrangement between attitude and mathematical achievement. Bernstein (1964) maintains that, if feelings experienced over a period of time lead to a particular self-image on the part of the students, this self-image influences their future performance, which, in turn, affects the students' actual performance.

Aiken (1970, 1976) in two comprehensive reviews of previous research findings concluded that at all academic levels, attitude toward mathematics has a definite predictive effect on final success in mathematics.

Logic for Study

At the 1968 convention of the American Association of Junior Colleges [the name of this organization was changed in 1972 to The American Association of Community and Junior Colleges], one of the key issues discussed was the 'disadvantaged student in the junior college'. Several of the speakers...emphasized that the problems of the disadvantaged varied tremendously from city to city, from region to region, and from junior college to junior college...The same can be said for almost all programs and endeavors in the two-year college. The junior college must be willing to design programs and instructional procedures to accommodate the peculiar needs of the local community. The same questions need to be raised in all two-year
colleges, but the answers may vary tremendously from one institution to another. Junior colleges are going to have to find solutions to their own peculiar problems. (Roueche & Boggs, 1968, P. 54).

The research conducted by the writer was concerned with the design of a model for predicting academic success for underprepared community college students. The equations and information generated may only be applicable to Lake Michigan College for the student population included in the study; however, the method should have wide generalizability.

The basic reasoning for this study, based on past research findings, was as follows:

If GPA or HSR can be used as a measure of academic achievement, and,

If SAT, ACT, and other norm-referenced standardized test scores predict almost as well as one another, and,

If standardized test scores predict almost as well as GPA or HSR, and,

If all of these (GPA, HSR and standardized test scores) are measures of past academic achievement, and,

If a criterion referenced screening test, keyed to instructional objectives, could be considered as a measure of past academic achievement, then;

Could this criterion referenced test be used to predict GPA in a mathematics class?

If attitude alone can predict 20 percent of the variance in grade;

Would the predictability of the intellective independent
variable, criterion referenced test score, coupled with an easily administered non-intellective variable measure, attitude, give relatively the same multiple correlation (or better) that has been found in past research on predictive studies?
CHAPTER III

PROCEDURES AND METHODOLOGY

Nature of the Study

This study was of an experimental-survey type research design. The purpose was to explore the predictability of academic achievement, demographic characteristics of the student populations and the effect of attitude on academic success for two levels of underprepared mathematics students in the community college.

Underprepared students form a heterogeneous subgroup of the community college population. To classify all students whose past learning achievement in mathematics is lower than college level into one group would be foolhardy (Losak, et al., 1970). Two levels of mathematics classes are offered for the underprepared students at Lake Michigan College. The higher level class, Intermediate Algebra, is clearly defined and covers approximately the mathematical content of algebra II and III, normally offered in high school. The lower level mathematics class, Basic Mathematics, is actually a combination of many grade levels of elementary and secondary school mathematics content. The basic assumption of the course is that students enrolling know the addition and multiplication facts and have had some exposure, probably unsuccessful exposure, to junior high school mathematics.
There are degrees of underpreparedness. For this reason, this study treated the two mathematics levels as separate and distinct groups. This study could be considered as parallel studies conducted at the same point in time, in the same manner, using the same independent and dependent variables, but two different populations.

The student information used in this study was readily available at an open door community college. Its collection was not disruptive or threatening to students, educators, or administrators. Each community college is different, a reflection of the local community's educational goals. The findings of this research are restricted to the college under study, but the model developed by this study should have application to most community college situations.

Hypotheses

The experimental hypotheses that were tested in this study fell into three main areas: 1) prediction equations; 2) attitude measures; and 3) student demographic characteristics.

**Prediction equation hypotheses**

**Hypotheses I**

a) An interaction effect does not exist between race, attitude, and academic achievement for students enrolled in Basic Mathematics.

b) An interaction effect does not exist between race, attitude, and academic achievement for students enrolled in Intermediate Algebra.
Hypothesis II

a) An interaction effect does not exist between sex, attitude, and academic achievement for students enrolled in Basic Mathematics.

b) An interaction effect does not exist between sex, attitude, and academic achievement for students enrolled in Intermediate Algebra.

Hypothesis III

a) An interaction effect does not exist between age, attitude, and academic achievement for students enrolled in Basic Mathematics.

b) An interaction effect does not exist between age, attitude, and academic achievement for students enrolled in Intermediate Algebra.

Hypothesis IV

a) A predictive equation based on criterion referenced screening test score, a measure of attitude toward mathematics, and demographic characteristics, will not predict academic achievement in Basic Mathematics, as well as previous research findings.

b) A predictive equation based on criterion referenced screening test score, a measure of attitude toward mathematics, and demographic characteristics, will not predict academic achievement in Intermediate Algebra, as well as previous research findings.

Hypothesis V

a) The prediction equation generated will not be valid when applied to a similar group of Basic Mathematics students.

b) The prediction equation generated will not be valid when applied to a similar group of Intermediate Algebra students.
Hypothesis VI

a) There is no difference in predictability in Basic Mathematics based on race.

b) There is no difference in predictability in Intermediate Algebra based on race.

Hypothesis VII

a) There is no difference in predictability in Basic Mathematics based on sex.

b) There is no difference in predictability in Intermediate Algebra based on sex.

Hypothesis VIII

a) There is no difference in predictability in Basic Mathematics based on age.

b) There is no difference in predictability in Intermediate Algebra based on age.

Attitude

Hypothesis IX

a) Students enrolled in Basic Mathematics do not experience an attitude change during the semester.

b) Students enrolled in Intermediate Algebra do not experience an attitude change during the semester.

Hypothesis X

a) Attitude change is not directly related to academic achievement in Basic Mathematics.

b) Attitude change is not directly related to academic achievement in Intermediate Algebra.
Demographic characteristics

Hypothesis XI

a) Students enrolled in Basic Mathematics possess demographic characteristics which are the same as the total school population's demographic characteristics.

b) Students enrolled in Intermediate Algebra possess demographic characteristics which are the same as the total school population's demographic characteristics.

Hypothesis XII

a) There is no difference in the demographic characteristics of successful and nonsuccessful Basic Mathematics students.

b) There is no difference in the demographic characteristics of successful and nonsuccessful Intermediate Algebra students.

Sample and Manner of Selection

During the first two weeks of the spring semester, 1978, a criterion referenced mathematics test and the Aiken-Dreger Revised Math Attitude Scale were administered to all students who had enrolled and were attending Basic Mathematics (090) and Intermediate Algebra (101) at Lake Michigan College. Each student was also asked to complete a duplicate Registration Form A at this time. The Aiken-Dreger test was again administered to those students still attending class at the close of the spring semester. Community colleges often have a flexible registration period. Students who had not taken the screening test and attitude test during the first two weeks of the
spring semester were excluded from the sample since it was believed that
the attitude test should be administered during a narrow time-frame.
Students who were repeating the courses were also excluded.

Eighty-two students enrolled in Basic Mathematics and forty-five
students enrolled in Intermediate Algebra were included in the study.
To confirm that the sample populations were representative of past
mathematics classes at Lake Michigan College (LMC), a one-way analysis
of variance of the criterion referenced test scores of all students
enrolled in Basic Mathematics and Intermediate Algebra for fall and
spring semester was generated. No significant difference was found in
either group (α = 0.05).

Table 3.1 Analysis of Variance: Fall 1977 and Spring 1978, Basic
Mathematics Criterion Referenced Test Scores.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
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<td>126.744</td>
<td>126.7</td>
<td>.379</td>
<td>.540</td>
</tr>
<tr>
<td>Error</td>
<td>97</td>
<td>32488.26</td>
<td>334.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
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<td>1.728</td>
<td>1.728</td>
<td>.171</td>
<td>.680</td>
</tr>
<tr>
<td>Error</td>
<td>93</td>
<td>938.498</td>
<td>10.090</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total sample of 127 students was categorized by course level,
Basic Mathematics or Intermediate Algebra. A table of random numbers

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was used for the separation of the students at each course level into two equal groups, sample and validation. If an odd number of students appeared in a sample, the extra student was randomly excluded from the group. To determine if the sample and validation groups for each level of mathematics course were statistically the same, a one-way analysis of variance was calculated based on the criterion referenced screening test score. No significant difference was found (α = .05).

Table 3.2 Analysis of Variance; Sample and Validation Basic Mathematics Criterion Referenced Test Scores.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
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<td>215.069</td>
<td>215.069</td>
<td>.609</td>
<td>.443</td>
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<tr>
<td>Error</td>
<td>80</td>
<td>28267.115</td>
<td>353.337</td>
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<td></td>
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</tbody>
</table>

Analysis of Variance; Sample and Validation Intermediate Algebra Criterion Referenced Test Scores.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>5.460</td>
<td>5.460</td>
<td>.504</td>
<td>.488</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>454.784</td>
<td>10.828</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The final groups in this study consisted of four subgroups: Basic Math sample, n = 41; Basic Math validation, n = 41; Intermediate Algebra sample, n = 22; Intermediate Algebra validation, n = 22.

Course Description and Methodology

At the time of this study, underprepared students enrolled in mathematics classes for a variety of reasons, some of which were:
1) a perceived need on the student's part, 2) recommendation of advisor or instructor, or 3) program requirement. Enrollment was voluntary. Although the college catalog stated that satisfactory completion of a specified level of mathematics was a prerequisite for various courses, Lake Michigan College, in keeping with the open admissions policy, did not exclude students from a course on the basis of diagnosed mathematical proficiency/deficiency. The results of the screening test lead only to a recommendation on the part of the instructor or advisor for correct class placement. The students were free to make their own decisions concerning the mathematics class in which they enrolled.

The course description for Basis Mathematics was as follows:

090-091 BASIC MATHEMATICS - ELEMENTARY ALGEBRA

This is a self-paced, individualized course in basic mathematics and/or elementary algebra. Each student will be placed by testing at their appropriate level at the beginning of the course. After proficiency at the basic math level is demonstrated, the student may elect to receive (090) Basic Mathematics credit or continue on to complete the Elementary Algebra (091) curriculum. Basic Mathematics covers: Whole Number, Fractions, Decimals, Ratio and Proportion, Percent, and Practical Geometry. Elementary Algebra covers all material normally covered in one year beginning algebra course. Credit hours do not apply toward transfer. (Lake Michigan College catalog, 1977-78, P. 87).

The instructional strategy of the Basic Mathematics course was based on the Personalized System of Instruction (PSI) as defined by Keller (Keller, 1968) incorporating the mastery learning model of Bloom (1968) and Postlewaite's audio-tutorial approach (Postlewaite, 1969). The students enrolled for a specific fifty minute period, meeting four times each week in the Math Lab. However, it was not necessary
that students came to the Math Lab at the assigned time. The only requirement was that at least sixty hours per semester be spent in the Math Lab. The Math Lab was open forty hours per week and staffed by mathematics instructors, one paraprofessional and six trained peer tutors. Students were encouraged to avail themselves of its facilities at any time convenient for them. Students elected to take tests demonstrating proficiency as they chose. Grades were based on the number of subunit tests passed with a minimum of eighty percent proficiency level.

The course description for Intermediate Algebra was as follows:

101 INTERMEDIATE ALGEBRA

This course is designed to provide students with sufficient algebraic knowledge and skills for success in subsequent mathematics or science courses. The study includes a brief review of the four fundamental operations, sets and real number system, factoring, fractions, linear and fractional equations and inequalities, functions and graphs, systems of equations, determinants and Cramer's rule, exponents and radicals, quadratic equation.

Prerequisite: Satisfactory completion (C or better) of Mathematics 090, 091, 100 or high school algebra. (Lake Michigan College catalog, 1977-78, P. 87).

The course was taught in a lecture/discussion format with audio tapes available in the Math Lab as supplementary help. The classes met on a regularly scheduled fifty-minute per day, four times per week basis and were taught by three instructors. Attendance at the prescribed times was expected. Tests were given on an instructor scheduled basis. Grades were determined by the averaged percentage of these tests.
Independent Variables

The independent variables were selected with consideration given to the analysis of previous prediction studies and to the availability of data at Lake Michigan College.

Criterion referenced tests

At the time of this study, past research findings consistently suggested that a measure of past academic achievement was predictive of future academic success. High school grade point average (HSGPA), high school rank (HSR), and many types of norm-referenced standardized test had been used to measure this past academic achievement. Often this type of information is not readily available to the community college.

Presently, new teaching methodology is being implemented in community colleges to deal with the heterogeneity of student bodies. Criterion referenced testing is often an integral part of this new teaching methodology. Tests are administered as part of the normal educational process and are, therefore, available for each student enrolled in a class. This was the case for underprepared mathematics classes at Lake Michigan College (LMC). Statistical procedures used for determining the reliability and validity of norm-referenced tests were not applicable to these criterion referenced tests (Popham & Husek, 1969).

It had been the LMC mathematics department's policy to give screening tests to students enrolled in all mathematics courses below the calculus level at the beginning of each semester. These
tests were of two forms, Level I and Level II.

Level I screening test

At the time of this study, the Level I screening test was a criterion referenced test directly related to the instructional objectives to be covered in Basic Mathematics (090) (appendix). Three forms of the test were developed by Dr. Joanna S. Burris and were directly keyed to the program, Basic Mathematics: an Individualized Approach, which was used in the basic mathematics course (Burris, 1974). Two additional forms of this test had been developed by the math faculty at LMC. The test had been used at LMC since the inception of the Math Lab, spring semester, 1974. Students receiving at least 80 percent on any of the six subsections of the test were given credit for having completed those units and could omit them from their course of study. The test was, therefore, used as a decision making tool in designing an individualized program for each student. If a student demonstrated proficiency in four or more of the six subsections of the test, a recommendation was made to the student that s/he consider enrolling in a mini-course to remediate math deficiencies and attempt the Level II screening test.

Level II screening test

The Level II screening test was a criterion referenced test related to a sample of the mathematical skills a student should have acquired in past arithmetic and algebra courses (appendix). The test was originally developed by the mathematics department of Western Michigan

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University and had been in use at LMC for the four years preceding this study. Students were expected to pass approximately 50 percent of the problems to be considered proficient enough in mathematical skills to enroll in Intermediate Algebra. A 75 percent competency level was expected of students enrolled in College Algebra, Pre-calculus Algebra and Trigonometry. These cut-off points were arbitrarily decided upon by the department, but had appeared to serve the purpose of identification of students with gross mathematical deficiencies.

Results of both Level I and Level II screening test scores were used as advisory tools for student placement. No student was excluded from a course on the basis of test results. In keeping with the open admissions policy of the community college, enrollment in all levels of mathematics classes was on a voluntary basis.

Criterion referenced screening test scores were chosen as one of the independent variables in this study.

**Attitude**

Attitude toward mathematics has been shown to correlate significantly with mathematics achievement. In fact, the literature reviewed for this study suggested that attitude toward a subject may be one component of the students' actual mathematical achievement. Motivation, personality characteristics, anxiety, "mathaphobia", all may be expressed in a measure of attitude.

The Aiken-Dreger Revised Math Attitude Scale (appendix) was chosen to measure attitude for several reasons:

1) The scale was developed, revised and validated using first
year college students as the population.

2) Aiken and Dreger report a test/retest reliability of $r = .94$ (Shaw & Wright, 1967).

3) The scale was short in length and could be administered in about five minutes, thus, it offered a minimum of disruption to college routine.

4) The reading level of the instrument appeared to be adequate for a group that might have reading problems (Losak, 1973) and yet was not offensive to a group of adults -- it did not 'talk-down' to them.

The Aiken-Dreger Revised Math Attitude Scale was submitted to a panel of educators (the staff of the Mathematics Department at LMC) to determine its content and face validity. The panel found it to be acceptable. During the semester preceding this study, the scale was field tested with those students then enrolled in Basic Mathematics and Intermediate Algebra at LMC (fall semester, 1977).

In 1977, the Aiken-Dreger test was a five option Likert-type scale with ten reversals on twenty responses. The response options were: strongly disagree (score 0); disagree (score 1); undecided (score 2); agree (score 3); and strongly agree (score 4). For each student, the scale value for the marked items were totaled, with a maximum score of 80. This yielded an interval type measure of attitude toward mathematics.

**Demographic characteristics**

Each student enrolling for one or more classes at LMC was asked to complete Registration Form A (appendix). This form provided the following demographic information: name, address, birth-date, phone
number, high school attended, high school graduation year, sex, marital status, race, college status, veteran status, financial aid status, and field of study. An optional section was also included which yielded information on parents' education, future academic plans, residence, family income, hours of employment and reasons for attending LMC. Since it was not possible to separate from the total school registration forms those students enrolled in Basic Mathematics and Intermediate Algebra, all students enrolled in these two courses were required to complete a second copy of Registration Form A during the first week of class.

Other than name, address, birth-date, and phone number, the students completed the form by choosing the appropriate category in response to each question. The majority of information gathered from this form was nominal data.

Dependent Variable

At the end of the semester two academic measures were obtained for all students included in this study; a measure of academic success -- final grade in class, and a measure of academic achievement -- overall test percentage of Intermediate Algebra students and number of subunits mastered for Basic Mathematics students.

Normally, grades in Intermediate Algebra were based upon the averaged percentage of tests: 90 percent and above = A; 80-89 percent = B; 70-79 percent = C; 60-69 percent = D; below 60 percent = E. Some modification by the individual instructors might have occurred. For this reason, the actual percentage used to determine the final grade was also obtained from the instructors' grade books. It should be
noted that each instructor was free to give as many tests as they wished, in whatever form they chose. No effort was made to account for variance between instructors.

Grades in Basic Mathematics were based primarily on the number of subunits completed. However, modification of the grading criteria occurred based on the amount of time spent in the Math Lab (appendix). For this reason, the actual number of subunits passed with 80 percent or better proficiency was obtained from the Math Lab student records.

Procedure for Information Collection

The Aiken-Dreger Revised Math Attitude Scale and the appropriate level criterion referenced screening test were administered in class testing sessions (during normal class meeting times) during the first two weeks of spring semester, 1978, to all students attending Basic Mathematics and Intermediate Algebra classes at LMC. A duplicate Registration Form A was completed by each student during this two week period.

A second measurement of attitude toward math was taken for all sample students (still attending class) near the completion of each course, however, the actual point in time for administering this post-semester attitude scale varied according to the level of the mathematics class.

Intermediate Algebra was an instructor-paced course. The attitude measure was taken in class testing sessions during the final week of the spring semester -- 1978. Basic Mathematics was a self-paced course with students finishing at their own rate. As students completed
unit five, they were asked by the instructional staff to assess the amount of work they hoped to complete during the remainder of the semester. If the student appeared to be close to fulfilling their chosen course objectives, the attitude scale was administered at that time. All students who had not completed the second attitude measurement instrument by the first week in May were asked to complete one at that time, regardless of the amount of work yet to be completed.

At the close of the semester, measures of academic success and academic achievement were collected. Data concerning Intermediate Algebra students' final grades and averaged test percentage were collected from the instructors' record books. Data concerning Basic Mathematics students' final grades and number of subunits mastered were collected from the students' Math Lab records.

Statistical Assumptions

Statistical tests can be classified as parametric or non-parametric. In order to correctly use most non-parametric tests, the basic assumptions of randomness and independence must be met (Siegel, 1956). In order to correctly use analysis of variance techniques or regression analysis (parametric tests), four basic assumptions must be met:

1) The scores were sampled at random
2) from normal populations
3) with equal variances
4) and the different samples are independent. (Glass & Stanley, 1970, P. 340).

A modification to assumption three (3) occurs: "When the sample
sizes are equal the effect of heterogeneous variance on the level of significance of the F test is negligible." (Glass & Stanley, 1970, P. 372). The data collected in this study appeared to meet the basic assumptions.

Data Classification

Age

Age was recorded by years taken from the birthdate listed on the Registration Form A. Age was then dichotomized into two groups: 1) 23 years and younger = college age; and 2) over 23 years of age = older than college age. Students who had not begun their college education by the age of 23 years were not considered to be of normal college age. This data is nominal data.

Race

Race was recorded in five categories as given on Registration Form A. Very few students in the sample checked the categories of American Indian or Alaskan Native, Asian or Pacific Islander, Hispanic. The vast majority of students fell into the White or Black classification. For the purposes of this study, student race was dichotomized into two groups: 1) White; and 2) Non-white. This data was nominal data.

Sex

Sex was recorded in two categories as given on the Registration Form A; male or female. This data is nominal data.

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Criterion referenced screening test score

Basic Mathematics range in score 0 to 100. Intermediate Algebra range in score 0 to 20 is interval data.

Attitude measure

Range in score 0 to 80 is interval data.

Academic achievement

Basic Mathematics range in score 0 to 28 subunits is interval data. Intermediate Algebra 0 to 100 percent is interval data.

Academic success

Grades were dichotomized into two groups; success = A, B, C: non-success = D, E, W. This is nominal data.

All other data that was collected is considered to be nominal data.

Statistical Procedures

The statistical procedures that were used in this study were of five types: 1) regression analysis; 2) two-factor analysis of variance; 3) correlated t-test; 4) chi-square; and 5) Pearson product-moment correlation test. The calculations were done using Western Michigan University's PDP 10 computer facilities and the Statistical Package for the Social Sciences (SPSS) (Nie, et al., 1975). "SPSS is an integrated system of computer programs designed for the analysis of social science data." (Nie, 1975, P. 1). An overview of each of...
the five statistical procedures is explained in the following section.

**Regression analysis**

Multiple regression analysis was used to generate prediction equations for hypotheses IV, VI, VII and VIII. (Nie, et al., 1975, Chapt. 20, P. 320-367).

Multiple regression is a general statistical technique through which one can analyze the relationship between a dependent or criterion variable and a set of independent or predictor variables...Through multiple regression techniques the researcher could obtain a prediction equation that indicates how scores on the independent variables could be weighted and summed to obtain the best possible prediction...for the sample. The researcher would also obtain statistics that indicate how accurate the prediction equation is and how much of the variation...is accounted for by the joint linear influences. (Nie, et al., P. 321).

Regression analysis could be thought of as a procedure whereby the relationship between the independent variable(s) and the dependent variable are plotted on a graph. A line is determined and adjusted until it has the "best fit" defined as: all points lying as close to the line as possible. "Best fit" is calculated by a technique called the least squares or the difference from the actual score point to the prediction line (residuals) squared and summed. From the position of this line an equation is generated. The slope of the equation (called the constant term), plus the relative contribution to the prediction equation of each independent variable (the actual score of that independent variable) times a unique, weighted coefficient (called the regression coefficient) gives the predicted score.

The equations generated by regression analysis are of the
The correlation between the combined contributions of the independent variables and the dependent variable is known as $R$, the multiple correlation coefficient. The multiple correlation coefficient squared indicates the amount of variance that is accounted for, overall, in the dependent variable and is called the coefficient of determination, $R^2$. "The overall accuracy of the prediction equation is reflected by $R^2$, the proportion of variation explained by the variables included in the regression equation." (Nie, et al., P. 331).

In a step-wise regression analysis, the first independent variables is entered on the basis of the strength of its unique correlation with the dependent variable ($r$), a regression analysis is done and the $R$ and $R^2$ are calculated. As each new variable is entered, the regression analysis is repeated, but an additional statistic is generated called increase in $R^2$. This allows the researcher to examine, in detail, the relative contribution of each independent variable.

Testing students is expensive in terms of time and money. An independent variable may add to the coefficient of determination such a small amount of accuracy that its data collection would not be cost-effective. After each independent variable has entered in step-wise regression, a one-way analysis of variance is calculated to determine the significance of the generated prediction equation.
Two-way analysis of variance

Hypotheses I, II and III were tested using two-way analysis of variance with unequal frequency.

In a one-way analysis of variance a ratio of observed differences divided by an error term is used to test the hypothesis. "The basis of analysis of variance (ANOVA) is the decomposition of the variation or sums of squares corrected for the mean (SS)." (Nie, et al., P. 400).

Two-way analysis of variance is an extension of one-way analysis of variance. Two-way ANOVA is a statistical procedure that tests not only the effect of each of the separate independent variables on the dependent variable, but also tests the interaction effect of the two independent variables on the dependent variable. For example: the effect of each independent variable (expressed as $\alpha_i$ and $\beta_j$) may be so small that each contributes very little to the dependent variable. However, acting in concert (expressed as $\alpha_1\beta_{ij}$), the effect of these two variables may be magnified to a point where their interaction is significant. "The first task of ANOVA with factorial design is to evaluate the overall effect and the interaction effect." (Nie, et al., P. 403). In a two-way ANOVA there will be three effects -- the effect of factor A, the effect of factor B, and the interaction effect of these two factors. The model upon which two-way ANOVA is based is:

$$X_{ijk} = \mu + \alpha_i + \beta_j + \alpha \beta_i j + e_{ij}$$

where

- $\mu$ = mean of the group
- $\alpha_i$ = the excess of data above or below $\mu$ for those scores at the $i$th level of factor A
- $\beta_j$ = the excess of data above or below $\mu$ for those scores at the $j$th level of factor B

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\( \alpha_{ij} \) = the unique result of combining level \( i \) of factor A
with level \( j \) of factor B

\( e_{ijk} \) = error term

(Glass & Stanley, 1970, PP. 402 & 403)

Null hypothesis

There was no interaction effect between the independent variables
and the dependent variable.

\[ H_0: \text{all } \alpha_{ij} = 0 \]

Alternate hypothesis

There was an interaction effect between the independent variable
and the dependent variable.

\[ H_1: \alpha_{ij} \neq 0 \text{ for at least one } \alpha_{ij} \]

Assumptions

It is assumed that the \( n \) observations in any one of the IJ cells
come from a normal distribution with variances which is constant for
each cell, and that IJ samples are independent of one another (Glass

Test Statistic

\[ F_A = \frac{MS_A}{MS_W}; \quad F_B = \frac{MS_B}{MS_W}; \quad F_{AB} = \frac{MS_{AB}}{MS_W} \]

where: \( MS_A = \text{mean square of factor A} \)

\( MS_B = \text{mean square of factor B} \)
\[ MS_{AB} = \text{mean square of the interaction} \]
\[ MS_W = \text{mean square within} \]

Critical values

For \[ F_A: \quad 1 - \alpha^F (I-1), \, IJ(n-1) \]
\[ F_B: \quad 1 - \alpha^F (J-1), \, IJ(n-1) \]
\[ F_{AB}: \quad 1 - \alpha^F (I-1)(J-1), \, IJ(n-1) \]

Level

\[ \alpha = .05 \]

Correlated t-test

Hypotheses V, IX, and X were tested by means of correlated t-test.

A t-test for paired observations arranged case-wise is a test of treatment effect; often it is called a correlated t-test or a t-test of dependent means. The test is used to determine the significance of changes in scores. The basic problem is to determine whether or not a difference between the two samples implies a true difference in the population. (Glass & Stanley, 1970, P. 297; Nie, et al., P. 270).

Null hypothesis

The means of the two test scores were the same.

\[ H_0: \mu_1 - \mu_2 = 0 \]
Alternate hypothesis

The means of the two test scores were different.

\[ H_1: \mu_1 - \mu_2 \neq 0 \]

Assumptions

It is assumed that both samples are randomly drawn from normal populations with the same variance \( \sigma_x^2 \). (Glass & Stanley, P. 297).

Test statistic

\[ t = \frac{\bar{d}}{sd/\sqrt{n}} \]

where \( \bar{d} \) = mean of the differences

\( sd \) = standard deviation of the differences

Critical values

\[ -1 - (\alpha/2)t_{n-1} \text{ and } 1 - (\alpha/2)t_{n-1} \]

Level

\( \alpha = .05 \)

Chi-square test

Hypotheses XI and XII were tested by use of a chi-square test. Chi-square is a test of statistical significance to determine whether a systematic relationship exists between two variables. The frequencies of the various combinations of attributes are tabulated in...
a contingency table and a comparison is made between the expected and observed cell frequencies.

Null hypothesis

In two populations the proportions \( P_1 \) and \( P_2 \) of persons possessing a certain characteristic are equal.

\[ H_0: P_1 = P_2 \]

Alternate hypothesis

In two populations the proportions \( P_1 \) and \( P_2 \) of persons possessing a certain characteristic are different.

\[ H_1: P_1 \neq P_2 \]

Assumption

It is assumed that the two populations are random samples.

Test statistic

\[ X^2 = \sum_{i=1}^{r} \sum_{j=1}^{k} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \]

where \( O_{ij} \) = observed number of cases categorized in the \( ij \)th category

\( E_{ij} \) = expected number of cases categorized in the \( ij \)th category

Critical value

\[ 1 - \alpha X^2 \quad (I-1) \quad (J-1) \]
Level

\( \alpha = .05 \)

**Pearson product-moment correlation**

Hypothesis X was tested by means of a Pearson product-moment correlation.

A Pearson product-moment correlation coefficient (r) "is used to measure the strength of relationship between two interval-level variables...The correlation coefficient can also be defined as the covariance in X and Y divided by the product of their standard deviation." (Nie, et al., 1975, P. 280).

**Null hypothesis**

The correlation between the paired observation is equal to zero.

\[ H_0: \rho_{xy} = 0 \]

**Alternate hypothesis**

The correlation between the paired observations is not equal to zero.

\[ H_1: \rho_{xy} \neq 0 \]

**Assumptions**

It is assumed that a random sample of paired observation is drawn from a bivariant normal population (Glass & Stanley, 1970, p. 308).
Test statistic

\[ t = \frac{r_{xy}}{\sqrt{1 - r_{xy}^2} / (n-2)} \]

where \( r_{xy} \) = the Pearson product-moment correlation

Level

\[ \alpha = .05 \]
CHAPTER IV

RESULTS

Background Summary

This study dealt with twelve experimental hypotheses for each of two levels of mathematics classes offered for underprepared students at Lake Michigan College: Basic Mathematics and Intermediate Algebra. The hypotheses tested fell into three main areas: 1) prediction equations -- hypotheses I through VIII, 2) attitude -- hypotheses IX and X, and 3) student demographic characteristics -- hypotheses XI and XII. The total groups were used in all hypotheses except IV and V. In these two cases the two levels were randomly divided into two equal size groups: Basic Mathematics sample (n=41), Basic Mathematics validation (n=41) and Intermediate Algebra sample (n=22), Intermediate Algebra validation (n=22).

Dichotomization of Independent Variables

Hypotheses I, II, and III dealt with the interaction effect of race, sex or age and pre-semester attitude measures on final semester academic achievement. In order to test these three hypotheses it was necessary to dichotomize the independent variables of attitude, race, sex and age.

Attitude scores (maximum = 80) were dichotomized by the mean of the attitude score in each level of mathematics course. Both levels
were given the same Aiken-Dreger Revised Math Attitude Scale. The mean of the total Basic Mathematics group was found to be 44.89 with a standard deviation of 18.37 (n = 82). The mean of the total Intermediate Algebra group was found to be 45.23 with a standard deviation of 15.94 (n = 44). A decision was made to use 45 as the separation point to divide both levels into low- and high-attitude groups (low-attitude less than 45, high-attitude 45 or greater). Each class level was also dichotomized by sex (male, female), race (White, non-white), and age (below 23 years of age, 23 or older).

The vast majority of the students in this sample were classified either Black or White. In the Basic Mathematics group there was one American Indian and one Hispanic. The Intermediate Algebra group was composed entirely of Black or White students. The decision was made to dichotomize race as White or non-white.

The traditional assumption, that students will complete high school at approximately 18 years of age and may then continue on to higher education, was used as the basis for determining the separation point for the dichotomization by age. Students who were attending college past the age of 22 years could probably have been classified as part of the nontraditional group. The decision was made to classify all students 23 years of age or older as older than college age. Those students under 23 years of age were classified as belonging to the college age group. The numbers and percentages of the dichotomized groups are shown in Table 4.1.
Table 4.1 Numbers and Percentage of Dichotomized Groups by Race, Age, and Sex.

<table>
<thead>
<tr>
<th></th>
<th>Basic Mathematics</th>
<th>Interchangeable Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 82</td>
<td>n = 44</td>
</tr>
<tr>
<td>Male</td>
<td>32 (39.0%)</td>
<td>32 (72.7%)</td>
</tr>
<tr>
<td>Female</td>
<td>50 (61.0%)</td>
<td>12 (27.3%)</td>
</tr>
<tr>
<td>White</td>
<td>46 (56.1%)</td>
<td>41 (93.2%)</td>
</tr>
<tr>
<td>Non-white</td>
<td>36 (43.9%)</td>
<td>3 (6.8%)</td>
</tr>
<tr>
<td>College age</td>
<td>33 (40.2%)</td>
<td>35 (79.6%)</td>
</tr>
<tr>
<td>Older</td>
<td>45 (54.9%)</td>
<td>7 (15.9%)</td>
</tr>
<tr>
<td>Not available</td>
<td>4 (4.9%)</td>
<td>2 (4.5%)</td>
</tr>
</tbody>
</table>

Table 4.2 shows the mean of the final academic achievement scores for the dichotomized groups at each mathematics level. At both levels females scored higher than males. In the Basic Mathematics group the older students and White students attained higher levels of academic achievement. In the Intermediate Algebra group the reverse was true; the college age group and the non-white students attained higher levels of academic achievement.

Table 4.2 Mean of Academic Achievement of Dichotomized Groups by Race, Age and Sex.

<table>
<thead>
<tr>
<th></th>
<th>Basic Mathematics</th>
<th>Intermediate Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>maximum = 28</td>
<td>maximum = 100</td>
</tr>
<tr>
<td></td>
<td>( \bar{X} )</td>
<td>( \bar{X} )</td>
</tr>
<tr>
<td>Male</td>
<td>17.50</td>
<td>77.49</td>
</tr>
<tr>
<td>Female</td>
<td>17.90</td>
<td>86.84</td>
</tr>
<tr>
<td>White</td>
<td>19.11</td>
<td>79.89</td>
</tr>
<tr>
<td>Non-white</td>
<td>16.00</td>
<td>81.57</td>
</tr>
<tr>
<td>College</td>
<td>16.15</td>
<td>79.77</td>
</tr>
<tr>
<td>Older</td>
<td>18.82</td>
<td>78.90</td>
</tr>
</tbody>
</table>

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Interaction Effect

In addition to the effect of attitude alone on academic achievement, the effect of the other independent variables (race, sex or age) was also of interest. If the effect for each level of the second independent variable (race, sex or age) was not the same, an interaction between these independent variables and attitude would exist. The variables would not only be acting alone, but also in concert with one another. The interaction effect between the two variables could magnify or diminish the effect of each independent variable acting alone. In order to examine the interaction effect of race, sex or age and attitude on the final academic achievement of the two levels of mathematics, the means and standard deviations of the final semester academic achievement for the dichotomized groups were determined. These statistics are given in Table 4.3.

Visual representations of the possible interaction effects are shown in Figures 4.1 through 4.6. Figure 4.1 shows a definite interaction effect between race and attitude on academic achievement of Basic Mathematics students. It appears that the low-attitude, White group obtained higher levels of academic achievement than the high-attitude White group. The expected relationship of low-attitude/low academic achievement, high-attitude/high academic achievement was true for the non-white group. Figure 4.4 illustrates the relationship between race and attitude on academic achievement of Intermediate Algebra students. Since no non-white students could be classified also as low-attitude students, a determination of the interaction effect was not possible.
Table 4.3 Mean and Standard Deviation of Academic Achievement and Number of Students in Dichotomized Attitude Groups.

<table>
<thead>
<tr>
<th></th>
<th>Basic Mathematics</th>
<th></th>
<th></th>
<th>Intermediate Algebra</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low attitude</td>
<td>high attitude</td>
<td>total</td>
<td>low attitude</td>
<td>high attitude</td>
<td>total</td>
</tr>
<tr>
<td></td>
<td>mean</td>
<td>s</td>
<td>n</td>
<td>mean</td>
<td>s</td>
<td>n</td>
</tr>
<tr>
<td>White</td>
<td>20.95</td>
<td>5.26</td>
<td>19</td>
<td>17.81</td>
<td>6.96</td>
<td>27</td>
</tr>
<tr>
<td>Non-white</td>
<td>12.17</td>
<td>6.69</td>
<td>12</td>
<td>17.92</td>
<td>6.43</td>
<td>24</td>
</tr>
<tr>
<td>Male</td>
<td>17.50</td>
<td>6.45</td>
<td>12</td>
<td>17.50</td>
<td>6.13</td>
<td>20</td>
</tr>
<tr>
<td>Female</td>
<td>17.58</td>
<td>7.82</td>
<td>19</td>
<td>18.10</td>
<td>7.05</td>
<td>31</td>
</tr>
<tr>
<td>College Age</td>
<td>15.29</td>
<td>7.09</td>
<td>17</td>
<td>17.06</td>
<td>6.16</td>
<td>16</td>
</tr>
<tr>
<td>Older</td>
<td>19.69</td>
<td>6.45</td>
<td>13</td>
<td>18.47</td>
<td>7.03</td>
<td>32</td>
</tr>
</tbody>
</table>

Figures 4.2 and 4.5 represent the interaction effect between sex and attitude on academic achievement for Basic Mathematics and Intermediate Algebra students, respectively. Much of the literature has indicated an interaction effect could be anticipated due to sex. Figures 4.2 and 4.5 could indicate that a slight interaction was taking place. In both cases the mean of the females' academic achievement was higher than that of the males.

Figures 4.3 and 4.6 illustrate the interaction effect between age and attitude on academic achievement for Basic Mathematics and

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Interaction Effect of Race and Attitude on Basic Math Academic Achievement

Interaction Effect of Sex and Attitude on Basic Math Academic Achievement

Interaction Effect of Age and Attitude on Basic Math Academic Achievement

Figure 4.1  Figure 4.2  Figure 4.3
Interaction Effect of Race and Attitude on Intermediate Algebra Academic Achievement

Figure 4.4

Interaction Effect of Sex and Attitude on Intermediate Algebra Academic Achievement

Figure 4.5

Interaction Effect of Age and Attitude on Intermediate Algebra Academic Achievement

Figure 4.6
Intermediate Algebra students, respectively. Although it appears in the Basic Mathematics group, that a significant interaction might be occurring due to age, this does not appear to be the case for Intermediate Algebra. It must be kept in mind that the Intermediate Algebra group had only one older student in the low-attitude group. The implications of Figure 4.6 may, therefore, be misleading or inconclusive. It is interesting to note that the older students in Basic Mathematics reached consistently higher levels of academic achievement, regardless of their attitude towards mathematics, while the reverse was true in the Intermediate Algebra group.

Hypotheses I, II, and III

A two-way analysis of variance (ANOVA) was calculated to test the statistical significance for each of the two subgroups in hypotheses I, II, and III. Since there were no non-white students with low attitude scores in the Intermediate Algebra group and only one older student with a low attitude score in the Intermediate Algebra group, it was not statistically feasible to determine these interaction effects.

Basic Mathematics

Hypothesis I(a) -- An interaction effect does not exist between race, attitude and academic achievement for students enrolled in Basic Mathematics.

There was found to be a significant interaction effect between race and attitude on academic achievement. The results of the two-way ANOVA are given in Table 4.4. Based on these findings hypothesis I(a)
was rejected — there did exist an interaction effect between race, attitude and academic achievement for students enrolled in Basic Mathematics (Figure 4.1).

Table 4.4 Two-way ANOVA between Attitude and Race on Basic Mathematics Achievement.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Squares</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>13.340</td>
<td>1</td>
<td>13.340</td>
<td>0.322</td>
<td>0.999</td>
</tr>
<tr>
<td>Race</td>
<td>201.742</td>
<td>1</td>
<td>201.742</td>
<td>4.877</td>
<td>0.029*</td>
</tr>
<tr>
<td>Two-Way Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude-Race</td>
<td>336.687</td>
<td>1</td>
<td>336.687</td>
<td>8.140</td>
<td>0.006*</td>
</tr>
<tr>
<td>Residuals</td>
<td>3226.430</td>
<td>78</td>
<td>41.364</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at .05 level

Hypothesis II(a) — An interaction effect does not exist between sex, attitude and academic achievement for students enrolled in Basic Mathematics.

On the basis of the results of the two-way ANOVA there was found to be no significant interaction between sex and attitude on academic achievement for students enrolled in Basic Mathematics. Hypothesis II(a) was not rejected (Figure 4.2).

Hypothesis III(a) — An interaction effect does not exist between age, attitude and academic achievement for students enrolled in Basic Mathematics.

On the basis of the results of the two-way ANOVA there was found to be no significant interaction effect between age and attitude on academic achievement for students enrolled in Basic Mathematics.
academic achievement for students enrolled in Basic Mathematics.
Hypothesis III(a) was not rejected (Figure 4.3).

Intermediate Algebra

Hypothesis I(b) — An interaction effect does not exist between race, attitude and academic achievement for students enrolled in Intermediate Algebra.

Since there were no non-white students in the low-attitude group, hypothesis I(b) could not be tested (Figure 4.4).

Hypothesis II(b) — An interaction effect does not exist between sex, attitude and academic achievement for students enrolled in Intermediate Algebra.

On the basis of the two-way ANOVA (Table 4.5), there was found to be no significant interaction effect between sex, attitude and academic achievement. Hypothesis II(b) was not rejected. It is interesting to note that although sex and attitude did not interact, it seems that sex alone had an effect upon academic achievement. This finding is in keeping with other research findings (Figure 4.5).

Table 4.5 Two-way ANOVA between Attitude and Sex on Intermediate Algebra Achievement.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Squares</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>691.439</td>
<td>2</td>
<td>345.719</td>
<td>2.063</td>
<td>0.140</td>
</tr>
<tr>
<td>Attitude</td>
<td>3.818</td>
<td>1</td>
<td>3.818</td>
<td>0.023</td>
<td>0.999</td>
</tr>
<tr>
<td>Sex</td>
<td>632.747</td>
<td>1</td>
<td>632.747</td>
<td>3.776</td>
<td>0.057</td>
</tr>
<tr>
<td>Two-Way Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude-Sex</td>
<td>12.759</td>
<td>1</td>
<td>12.759</td>
<td>0.076</td>
<td>0.999</td>
</tr>
<tr>
<td>Residuals</td>
<td>6032.112</td>
<td>36</td>
<td>167.559</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Hypothesis III(b) — An interaction effect does not exist between age, attitude and academic achievement for students enrolled in Intermediate Algebra.

Since there was only one older age group student in the low-attitude group, hypothesis III(b) could not be accurately tested statistically (Figure 4.6).

Hypothesis I, II, and III dealt with the interaction effect of race, sex or age and attitude on academic achievement at two levels of mathematics for underprepared community college students. The only significant interaction effect was found to be in the Basic Mathematics group between race and attitude on academic achievement.

Hypothesis IV

Hypothesis IV(a) — a prediction equation based on criterion referenced test score, a measure of attitude toward mathematics, and certain demographic characteristics, will not predict academic achievement in Basic Mathematics as well as past research findings.

By utilizing a multiple regression analysis for the Basic Mathematics sample group (n = 41) with the independent variables of screening test score and pre-semester attitude test score entered first in the step-wise regression and age, sex and dichotomized race entered last in the step-wise regression it was found that:

1) Screening test score entered first with an r of .513 and an $r^2$ of .263.

2) Pre-semester attitude score entered second with an r of .05, increasing the $R^2$ by only .004 to $R^2 = .267$. 

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3) Age entered third with an r of .339, increasing the $R^2$ by .037 to $R^2 = .304$.

4) Sex entered fourth with an r of -.025, increasing the $R^2$ by .003 to $R^2 = .307$.

5) Dichotomized race entered last with an r of .233, increasing the $R^2$ by .001 to $R^2 = .308$.

A summary of these results is given in Table 4.6.

Table 4.6 Regression Analysis Summary Table for Basic Mathematics Sample.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Simple R</th>
<th>Multiple R</th>
<th>R Square</th>
<th>RSQ Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening</td>
<td>0.513</td>
<td>0.513</td>
<td>0.263</td>
<td>0.263</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.051</td>
<td>0.517</td>
<td>0.267</td>
<td>0.004</td>
</tr>
<tr>
<td>Age</td>
<td>0.339</td>
<td>0.512</td>
<td>0.304</td>
<td>0.037</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.025</td>
<td>0.554</td>
<td>0.307</td>
<td>0.003</td>
</tr>
<tr>
<td>Race</td>
<td>0.233</td>
<td>0.555</td>
<td>0.308</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The final prediction equation generated by the regression analysis was:

$$Y' = 7.60259 + (.17646 \times \text{Screening test score}) + (.01411 \times \text{Attitude score}) + (.22192 \times \text{Age}) - (.93152 \times \text{Sex}) - (.44818 \times \text{Race}).$$

As can be seen in Table 4.6, the final equation with all five independent variables entered, reached a multiple correlation (R) of .5551 with final academic achievement and accounted for approximately 31 percent of the variance in academic achievement.

Past research has indicated that combining cognitive and affective variables to predict success for students of the type enrolled in Basic Mathematics -- underprepared, non-traditional -- can account for
20 to 40 percent of the variance in academic achievement (Trachtman, 1975). The results of this study confirmed these findings. Based on past research findings and the finding of this research, hypothesis IV(a) was rejected. A predictive equation based on criterion referenced test score, a measure of attitude toward mathematics, race, sex, and age, did predict academic achievement in Basic Mathematics as well as past research findings.

Hypothesis IV(b) -- a predictive equation based on criterion referenced test score, a measure of attitude toward mathematics, and certain demographic characteristics, will not predict academic achievement in Intermediate Algebra as well as past research findings.

By utilizing a multiple regression analysis for the Intermediate Algebra sample group (n = 22) with the independent variable of screening test score and pre-semester attitude test score entered first in the step-wise regression and age, sex and dichotomized race entered last in the step-wise regression, it was found that:

1) Screening test score entered first with an $r$ of .395 and an $r^2$ of .156.

2) Pre-semester attitude score entered second with an $r$ of .320, increasing the $R^2$ by .047 to $R^2 = .203$.

3) Age entered third with an $r$ of -.233, increasing the $R^2$ by .076 to $R^2 = .279$.

4) Dichotomized race entered fourth with an $r$ of .320, increasing the $R^2$ by .092 to $R^2 = .371$.

5) Sex entered last with an $r$ of .408, increasing the $R^2$ by .051 to $R^2 = .422$.
A summary of these results is given in Table 4.7.

Table 4.7  Regression Analysis Summary Table for Intermediate Algebra Sample.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Simple R</th>
<th>Multiple R</th>
<th>R Square</th>
<th>RSQ Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening</td>
<td>0.395</td>
<td>0.395</td>
<td>0.156</td>
<td>0.156</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.320</td>
<td>0.451</td>
<td>0.203</td>
<td>0.047</td>
</tr>
<tr>
<td>Age</td>
<td>0.223</td>
<td>0.528</td>
<td>0.279</td>
<td>0.076</td>
</tr>
<tr>
<td>Race</td>
<td>0.320</td>
<td>0.609</td>
<td>0.371</td>
<td>0.092</td>
</tr>
<tr>
<td>Sex</td>
<td>0.408</td>
<td>0.649</td>
<td>0.422</td>
<td>0.051</td>
</tr>
</tbody>
</table>

The final prediction equation generated by the regression analysis was:

\[ Y' = 26.92332 + (0.29066 \times \text{Screening test score}) + (0.19734 \times \text{Attitude Score}) - (0.81859 \times \text{Age}) + (23.86962 \times \text{Race}) + (8.34536 \times \text{Sex}). \]

As can be seen in Table 4.7, the final equation with all five independent variables entered reached a multiple correlation (R) of .64942 with final academic achievement in Intermediate Algebra and accounted for approximately 42 percent of the variance in academic achievement.

Past research findings dealing with Intermediate Algebra students have indicated that the multiple correlation achieved by combining high school mathematics average, standardized test score and the Aiken attitude score, ranged from R = .286 to R = .575 (Behr, 1973). Based on past research findings and the findings of this research, hypothesis IV(b) was rejected. A predictive equation based on criterion referenced test score, a measure of attitude toward mathematics, race, sex and age, did predict academic achievement in Intermediate Algebra as well as past research findings.
Hypothesis V

**Hypothesis V(a)** — The prediction equations generated will not be valid when applied to a similar group of Basic Mathematics students.

In order to test hypothesis V(a) the prediction equation generated in hypothesis IV(a), using the sample group of Basic Mathematics students, was applied to the validation group of Basic Mathematics students. The Basic Mathematics validation group's predicted success and actual success were then compared (Table 4.8).

<table>
<thead>
<tr>
<th>Predicted</th>
<th>Success</th>
<th>Non-success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success</td>
<td>25 (61.0%)</td>
<td>3 (7.3%)</td>
</tr>
<tr>
<td>Actual Non-success</td>
<td>6 (14.6%)</td>
<td>7 (17.1%)</td>
</tr>
</tbody>
</table>

The diagonal from top left to bottom right indicates the number and percentage of students correctly classified — 61 percent success/success, 17.1 percent nonsuccess/nonsuccess. Overall the prediction equation accurately classified Basic Mathematics students 78 percent of the time. On the basis of these findings hypothesis V(a) was rejected. The prediction equation generated was valid when applied to a similar group of Basic Mathematics students.
Hypothesis V(b) -- The prediction equation generated will not be valid when applied to a similar group of Intermediate Algebra students.

In order to test hypothesis V(b) the prediction equation generated in hypothesis IV(b), using the sample group of Intermediate Algebra students, was applied to the validation group of Intermediate Algebra students. The Intermediate Algebra validation groups predicted success and actual success rates were then compared (Table 4.9).

Table 4.9 Predicted and Actual Success of Intermediate Algebra Students in Number and Percentage.

<table>
<thead>
<tr>
<th></th>
<th>Predicted</th>
<th></th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Success</td>
<td>Non-success</td>
<td></td>
</tr>
<tr>
<td>Success</td>
<td>14 (63.7%)</td>
<td>1 (4.5%)</td>
<td></td>
</tr>
<tr>
<td>Actual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-success</td>
<td>7 (31.8%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
</tbody>
</table>

It was found that the prediction equation accurately classified Intermediate Algebra students as successful or nonsuccessful 64 percent of the time. On the basis of these findings hypothesis V(b) was rejected. The prediction equation generated was valid when applied to a similar group of Intermediate Algebra students.

Hypotheses VI, VII, & VIII

Hypotheses VI, VII, and VIII were predicated on the results of hypotheses I, II, and III. On the basis of these results, an interaction effect was found in Basic Mathematics based on race and
attitude on academic achievement and consequently hypothesis VI(a) was tested.

Hypothesis VI(a) -- There is no difference in predictability in Basic Mathematics based on race.

Two separate regression analyses were calculated using attitude scores and screening test scores as the independent variables for the White and non-white students enrolled in Basic Mathematics.

The prediction equation generated by the regression analysis for the non-white group was:

\[ Y' = 10.03823 + (0.14918 \times \text{Screening test score}) + (0.05768 \times \text{attitude test score}) \]

This prediction equation yields a multiple correlation of \( R = 0.38156 \) with academic achievement and accounts for approximately 14.5 percent of the variance in final academic achievement. A summary is given in Table 4.10.

Table 4.10 Regression Analysis Summary Table for Basic Mathematics Non-white Group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Simple R</th>
<th>Multiple R</th>
<th>R Square</th>
<th>RSQ Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Test Score</td>
<td>0.342</td>
<td>0.342</td>
<td>0.117</td>
<td>0.117</td>
</tr>
<tr>
<td>Attitude Test Score</td>
<td>0.188</td>
<td>0.382</td>
<td>0.146</td>
<td>0.029</td>
</tr>
</tbody>
</table>

The prediction equation generated by the regression analysis for the White group was:

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$Y' = 14.52508 + (.18703 \times \text{Screening Test Score}) - (.07046 \times \text{Attitude Test Score})$

The prediction equation yielded a multiple correlation of $R = .52408$ and accounted for approximately 27.5 percent of the variance in final academic achievement. A summary of the results is given in Table 4.11.

Table 4.11 Regression Analysis Summary Table for Basic Mathematics White Group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Simple R</th>
<th>Multiple R</th>
<th>R Square</th>
<th>RSQ Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Test Score</td>
<td>0.498</td>
<td>0.498</td>
<td>0.248</td>
<td>0.248</td>
</tr>
<tr>
<td>Attitude Test Score</td>
<td>-0.220</td>
<td>0.524</td>
<td>0.245</td>
<td>0.027</td>
</tr>
</tbody>
</table>

The prediction equations generated accounted for only 14 percent of the variance in academic achievement in the non-white Basic Mathematics group, while the White prediction equation generated accounted for 27 percent of the variance in academic achievement in the White Basic Mathematics group. On the basis of these findings, it would appear that the White group is more predictable than the non-white group. Hypothesis VI(a) was rejected. There was a difference in predictability in Basic Mathematics based on race.

Hypothesis IX

Hypothesis IX(a) — Students enrolled in Basic Mathematics do not experience an attitude change during the semester.

This hypothesis was tested by calculating the difference of
the means of the pre- and post-semester attitude scores for all Basic Mathematics students. A gain in score (maximum = 80) of 2.57 points was found in the mean of the attitude test scores. This gain in score was then tested for significance using a correlated t-test (Table 4.12). (Table 4.12 appears on next page.)

The gain in attitude score was found to have an actual probability of .078. It could be speculated that the change toward a more positive attitude for Basic Mathematics students was approaching significance. Since the chosen level of significance was established as .05, on the basis of these findings, hypothesis IX(a) was not rejected.

Hypothesis IX(b) -- Students enrolled in Intermediate Algebra do not experience an attitude change during the semester.

This hypothesis was tested by calculating the mean of the pre- and post-semester attitude scores for all Intermediate Algebra students. A gain in score of 3.39 points was found in the mean of the attitude test scores. This gain in score was tested for significance using a correlated t-test (Table 4,13). As was the case in the Basic Mathematics group, the gain was not found to be significant at the .05 level, having an actual probability of .074. It might be speculated that the change toward a more positive attitude was approaching significance. On the basis of this research finding, hypothesis IX(b) was not rejected.

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Table 4.12  t-test of Basic Mathematics Students' Pre- and Post-semester Attitude Test Scores.  
(N = 69)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>Difference Mean</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>T Value</th>
<th>df</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-semester Attitude</td>
<td>42.506</td>
<td>17.914</td>
<td>2.157</td>
<td></td>
<td></td>
<td></td>
<td>-2.5652</td>
<td>11.916</td>
<td>1.434</td>
</tr>
<tr>
<td>Post-semester Attitude</td>
<td>44.971</td>
<td>17.043</td>
<td>2.052</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.13  t-test of Intermediate Algebra Students' Pre- and Post-semester Attitude Test Scores.  
(N = 41)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>Difference Mean</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
<th>T Value</th>
<th>df</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-semester Attitude</td>
<td>46.171</td>
<td>15.208</td>
<td>2.375</td>
<td></td>
<td></td>
<td></td>
<td>3.3902</td>
<td>11.815</td>
<td>1.845</td>
</tr>
<tr>
<td>Post-semester Attitude</td>
<td>49.561</td>
<td>15.606</td>
<td>2.437</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Hypothesis X

Hypothesis X(a) -- Attitude change is not directly related to academic achievement in Basic Mathematics.

In order to test hypothesis X(a) a Pearson product-moment correlation between change in attitude score and final level of academic achievement in Basic Mathematics (based on the number of subunits completed) was calculated. A correlation of $r = .05$ was determined having a level of significance of .342. On the basis of this result, hypothesis X(a) was not rejected.

Hypothesis X(b) -- Attitude change is not directly related to academic achievement in Intermediate Algebra.

In order to test hypothesis X(b) a Pearson product-moment correlation between change in attitude score and final level of academic achievement was calculated. A correlation of $r = .2831$ was determined, having a level of significance of .038. On the basis of this result, hypothesis X(b) was rejected. Attitude change was directly related to academic achievement in Intermediate Algebra.

Hypothesis XI

Hypothesis XI -- Students enrolled in Basic Mathematics or Intermediate Algebra possess demographic characteristics which are the same as the total school population's demographic characteristics.

In order to test hypothesis XI data on the total Lake Michigan College (LMC) student population for spring semester, 1978, was
furnished by the LMC registrar. A chi-square statistic was calculated to test the difference between the proportion of Basic Mathematics and Intermediate Algebra students possessing certain demographic characteristics and the entire LMC student body's demographic characteristics. The results of the chi-squares are given in Table 4.14. The actual frequencies and percentages of each significantly different characteristic are given in Table 4.15 for Basic Mathematics and Table 4.16 for Intermediate Algebra.

Table 4.14 Chi-square for Basic Mathematics/Intermediate Algebra Students and Total LMC Student Population.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Basic Mathematics</th>
<th></th>
<th>Intermediate Algebra</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$X^2$</td>
<td>$p&lt;\alpha$</td>
<td>$X^2$</td>
<td>$p&lt;\alpha$</td>
</tr>
<tr>
<td>Residence</td>
<td>6.940</td>
<td>.074</td>
<td>26.179</td>
<td>.000*</td>
</tr>
<tr>
<td>Father's Education</td>
<td>10.349</td>
<td>.066</td>
<td>11.331</td>
<td>.045*</td>
</tr>
<tr>
<td>Mother's Education</td>
<td>9.945</td>
<td>.077</td>
<td>11.051</td>
<td>.050*</td>
</tr>
<tr>
<td>Future Plans</td>
<td>5.321</td>
<td>.256</td>
<td>26.914</td>
<td>.000*</td>
</tr>
<tr>
<td>Family Income</td>
<td>27.894</td>
<td>.000*</td>
<td>2.378</td>
<td>.498</td>
</tr>
<tr>
<td>Influential Person</td>
<td>16.481</td>
<td>.006*</td>
<td>8.602</td>
<td>.126</td>
</tr>
<tr>
<td>Hours Employed</td>
<td>18.769</td>
<td>.002*</td>
<td>11.391</td>
<td>.044*</td>
</tr>
<tr>
<td>Reason for Attending</td>
<td>5.469</td>
<td>.242</td>
<td>29.979</td>
<td>.000*</td>
</tr>
<tr>
<td>Reason for Selecting</td>
<td>4.240</td>
<td>.515</td>
<td>8.229</td>
<td>.144*</td>
</tr>
</tbody>
</table>

* significant at .05 level
Table 4.15 Number and Percentage of Significantly Different Demographic Characteristics — Basic Mathematics and Total LMC Population.

<table>
<thead>
<tr>
<th>Income</th>
<th>Basic Mathematics</th>
<th>LMC Population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>0 - 7500</td>
<td>26</td>
<td>55.3</td>
</tr>
<tr>
<td>7501 - 12000</td>
<td>6</td>
<td>12.8</td>
</tr>
<tr>
<td>12001 - 18000</td>
<td>4</td>
<td>8.5</td>
</tr>
<tr>
<td>18001 or more</td>
<td>11</td>
<td>23.4</td>
</tr>
</tbody>
</table>

Influential Person

<table>
<thead>
<tr>
<th></th>
<th>Basic Mathematics</th>
<th>LMC Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counselor</td>
<td>6</td>
<td>8.7</td>
</tr>
<tr>
<td>Employer</td>
<td>9</td>
<td>13.1</td>
</tr>
<tr>
<td>Friend</td>
<td>12</td>
<td>17.4</td>
</tr>
<tr>
<td>Self</td>
<td>35</td>
<td>50.7</td>
</tr>
<tr>
<td>Relative</td>
<td>5</td>
<td>7.2</td>
</tr>
<tr>
<td>College Rep.</td>
<td>2</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Hours Employed

<table>
<thead>
<tr>
<th></th>
<th>Basic Mathematics</th>
<th>LMC Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>27</td>
<td>46.6</td>
</tr>
<tr>
<td>1 - 9</td>
<td>3</td>
<td>5.2</td>
</tr>
<tr>
<td>10 - 19</td>
<td>2</td>
<td>3.4</td>
</tr>
<tr>
<td>20 - 29</td>
<td>10</td>
<td>17.2</td>
</tr>
<tr>
<td>30 - 39</td>
<td>4</td>
<td>6.9</td>
</tr>
<tr>
<td>40 or more</td>
<td>12</td>
<td>20.7</td>
</tr>
</tbody>
</table>
Table 4.16  Number and Percentage of Significantly Different Demographic Characteristics -- Intermediate Algebra and Total LMC Population.

<table>
<thead>
<tr>
<th>Residence</th>
<th>Intermediate Algebra</th>
<th></th>
<th>LMC Population</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Parents</td>
<td>26</td>
<td>76.5</td>
<td>884</td>
<td>38.8</td>
</tr>
<tr>
<td>Rental</td>
<td>4</td>
<td>11.8</td>
<td>512</td>
<td>22.5</td>
</tr>
<tr>
<td>Own Home</td>
<td>1</td>
<td>2.9</td>
<td>800</td>
<td>35.1</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>8.8</td>
<td>84</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Father's Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below High School</td>
<td>4</td>
<td>12.9</td>
<td>548</td>
<td>25.9</td>
</tr>
<tr>
<td>Part High School</td>
<td>0</td>
<td>0.0</td>
<td>299</td>
<td>14.1</td>
</tr>
<tr>
<td>High School Grad.</td>
<td>17</td>
<td>54.8</td>
<td>779</td>
<td>37.8</td>
</tr>
<tr>
<td>2-year Degree</td>
<td>4</td>
<td>12.9</td>
<td>132</td>
<td>6.2</td>
</tr>
<tr>
<td>4-year Degree</td>
<td>4</td>
<td>12.9</td>
<td>218</td>
<td>10.3</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>6.5</td>
<td>119</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Mother's Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below High School</td>
<td>1</td>
<td>3.2</td>
<td>423</td>
<td>19.9</td>
</tr>
<tr>
<td>Part High School</td>
<td>2</td>
<td>6.5</td>
<td>319</td>
<td>15.0</td>
</tr>
<tr>
<td>High School Grad.</td>
<td>22</td>
<td>71.0</td>
<td>1005</td>
<td>47.2</td>
</tr>
<tr>
<td>2-year Degree</td>
<td>3</td>
<td>9.7</td>
<td>168</td>
<td>7.9</td>
</tr>
<tr>
<td>4-year Degree</td>
<td>3</td>
<td>9.7</td>
<td>141</td>
<td>6.6</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0.0</td>
<td>73</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Future Plans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree Transfer</td>
<td>16</td>
<td>51.6</td>
<td>785</td>
<td>38.5</td>
</tr>
<tr>
<td>Degree-No Transfer</td>
<td>3</td>
<td>9.7</td>
<td>417</td>
<td>20.4</td>
</tr>
<tr>
<td>Transfer-No Degree</td>
<td>10</td>
<td>32.3</td>
<td>185</td>
<td>9.1</td>
</tr>
<tr>
<td>Certificate</td>
<td>1</td>
<td>3.2</td>
<td>236</td>
<td>11.6</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>3.2</td>
<td>418</td>
<td>20.5</td>
</tr>
<tr>
<td><strong>Hours Employed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>9</td>
<td>20.0</td>
<td>561</td>
<td>26.8</td>
</tr>
<tr>
<td>1 - 9</td>
<td>3</td>
<td>9.7</td>
<td>81</td>
<td>3.9</td>
</tr>
<tr>
<td>10 - 19</td>
<td>5</td>
<td>16.1</td>
<td>170</td>
<td>8.1</td>
</tr>
<tr>
<td>20 - 29</td>
<td>6</td>
<td>19.4</td>
<td>214</td>
<td>10.2</td>
</tr>
<tr>
<td>30 - 39</td>
<td>2</td>
<td>6.5</td>
<td>302</td>
<td>14.4</td>
</tr>
<tr>
<td>40 or more</td>
<td>6</td>
<td>19.4</td>
<td>768</td>
<td>36.6</td>
</tr>
<tr>
<td><strong>Reason for Attending</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prep. for Skill</td>
<td>5</td>
<td>15.6</td>
<td>638</td>
<td>29.8</td>
</tr>
<tr>
<td>Increase Work Ability</td>
<td>1</td>
<td>3.1</td>
<td>392</td>
<td>18.3</td>
</tr>
<tr>
<td>Prep. for Transfer</td>
<td>18</td>
<td>56.3</td>
<td>421</td>
<td>19.7</td>
</tr>
<tr>
<td>Growth</td>
<td>3</td>
<td>9.4</td>
<td>462</td>
<td>21.6</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>15.6</td>
<td>226</td>
<td>10.6</td>
</tr>
</tbody>
</table>

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A comparison of nine demographic characteristics between Basic Mathematics students and the total school population found that Basic Mathematics students differed significantly on three traits.

1) Family income -- Family income was found to be lower for Basic Mathematics students than for the entire school population. In the Basic Mathematics group 55.3% had family income in the $0 - 7500 range as compared to 23.3% of the total school population.

2) Influential person -- It appears that Basic Mathematics students were more influenced by counselors and friends than the total population. However, both groups cited 'self' as the main person who influenced their attendance at LMC. It was a personal decision to attend the community college.

3) Hours employed -- Basic Mathematics students were more likely not to be employed than the total school population. Roughly one-half of the Basic Mathematics students reported they did not work as compared to one-quarter of the total school population.

A comparison of the same nine demographic characteristics between Intermediate Algebra students and the total school population found that Intermediate Algebra students differed significantly on six traits.

1) Residence -- Intermediate Algebra students were much more likely to reside with their parents (76 percent) than the total school population (39 percent).

2 & 3) Father's and mother's education -- Both the fathers and mothers of Intermediate Algebra students were more likely to have reached a higher level of educational attainment than that of the parents of the total school population. Approximately 90 percent of the mothers of
Intermediate Algebra students and 87 percent of the fathers were classified as high school graduates or above compared to 65 percent of the mothers and 60 percent of the fathers of the total school population.

4) Future plans -- Future educational plans of Intermediate Algebra students were significantly different than the total school population. The majority of Intermediate Algebra students were planning to transfer to another college, either with or without an Associate degree (83.9 percent). In the total population 47.6 percent indicated transfer as their future educational plans.

5) Reason for attending LMC -- The reason checked for attending LMC was consistent with the future educational plans of the Intermediate Algebra students and different from the total population's reason. Of the Intermediate Algebra group 56.3 percent checked that their main reason for attending LMC was in preparation for transfer as compared to 20.3 percent of the total school population citing this reason.

6) Hours employed -- Approximately the same proportion of Intermediate Algebra students were not employed as the total school population. Those Intermediate Algebra students who did hold jobs, however, tended to be employed part-time (less than 30 hours) rather than full-time.

On the basis of these findings, hypothesis XI was rejected. Students enrolled in Basic Mathematics or Intermediate Algebra did possess demographic characteristics which were different from the total school population's demographic characteristics.
Hypothesis XII

There is no difference in the demographic characteristics of successful and nonsuccessful Basic Mathematics or Intermediate Algebra students.

In order to test hypothesis XII the students in Basic Mathematics and Intermediate Algebra were classified as successful if they received a final grade of A, B, or C, and unsuccessful if they received a final grade of D, E, W or I. A chi-square test of difference between groups was used to determine if the proportion of persons with various demographic characteristics were statistically different between successful and nonsuccessful students. Table 4.17 shows the results. In all cases, for both Basic Mathematics and Intermediate Algebra students, there was found to be no significant difference in demographic characteristics. On the basis of these findings, hypothesis XII was not rejected. (Table 4.17 appears on next page.)

Summary of Hypotheses

This study examined twelve experimental hypotheses for each of two levels of mathematics courses offered for underprepared students at Lake Michigan College during the spring semester, 1978. The rejection or non-rejection of these hypotheses, based on $\alpha = .05$, are summarized in Table 4.18.
Table 4.17 Chi-square Between Successful and Non-successful Students.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Basic Mathematics</th>
<th></th>
<th>Intermediate Algebra</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$X^2$</td>
<td>p</td>
<td>$X^2$</td>
<td>p</td>
</tr>
<tr>
<td>Age</td>
<td>2.761</td>
<td>.100</td>
<td>0.099</td>
<td>.754</td>
</tr>
<tr>
<td>Marital Status</td>
<td>0.008</td>
<td>.931</td>
<td>0.105</td>
<td>.746</td>
</tr>
<tr>
<td>Previous College</td>
<td>3.818</td>
<td>.282</td>
<td>5.566</td>
<td>.135</td>
</tr>
<tr>
<td>Vet. Status</td>
<td>3.449</td>
<td>.327</td>
<td>0.304</td>
<td>.859</td>
</tr>
<tr>
<td>Grant Status</td>
<td>0.801</td>
<td>.371</td>
<td>0.055</td>
<td>.815</td>
</tr>
<tr>
<td>Fresh/Soph Status</td>
<td>0.021</td>
<td>.886</td>
<td>0.040</td>
<td>.841</td>
</tr>
<tr>
<td>Residence</td>
<td>4.034</td>
<td>.258</td>
<td>2.445</td>
<td>.485</td>
</tr>
<tr>
<td>Mother's Ed.</td>
<td>3.578</td>
<td>.612</td>
<td>4.600</td>
<td>.331</td>
</tr>
<tr>
<td>Father's Ed.</td>
<td>2.723</td>
<td>.605</td>
<td>6.161</td>
<td>.187</td>
</tr>
<tr>
<td>Future Plans</td>
<td>2.669</td>
<td>.615</td>
<td>7.521</td>
<td>.111</td>
</tr>
<tr>
<td>Family Income</td>
<td>3.130</td>
<td>.372</td>
<td>2.958</td>
<td>.398</td>
</tr>
<tr>
<td>Influen. Person</td>
<td>3.576</td>
<td>.466</td>
<td>2.300</td>
<td>.317</td>
</tr>
<tr>
<td>Hours Employed</td>
<td>2.029</td>
<td>.845</td>
<td>5.577</td>
<td>.350</td>
</tr>
<tr>
<td>Reason Attend.</td>
<td>3.272</td>
<td>.513</td>
<td>0.970</td>
<td>.914</td>
</tr>
<tr>
<td>Reason Select.</td>
<td>3.560</td>
<td>.500</td>
<td>3.117</td>
<td>.374</td>
</tr>
</tbody>
</table>

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Table 4.18 Summary of Non-rejection or Rejection of Hypotheses.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Basic Mathematics</th>
<th>Intermediate Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Rejected</td>
<td>Not tested (No non-white students in low-attitude group)</td>
</tr>
<tr>
<td>II</td>
<td>Not rejected</td>
<td>Not rejected</td>
</tr>
<tr>
<td>III</td>
<td>Not rejected</td>
<td>Not tested (Only one older student in low-attitude group)</td>
</tr>
<tr>
<td>IV</td>
<td>Rejected</td>
<td>Rejected</td>
</tr>
<tr>
<td>V</td>
<td>Rejected</td>
<td>Rejected</td>
</tr>
<tr>
<td>VI</td>
<td>Rejected</td>
<td>Not tested (Based on results of hypotheses I, II &amp; III)</td>
</tr>
<tr>
<td>VII</td>
<td>Not tested (Based on results of hypotheses I, II &amp; III)</td>
<td>Not tested (Based on results of hypotheses I, II, &amp; III)</td>
</tr>
<tr>
<td>VIII</td>
<td>Not tested (Based on results of hypotheses I, II &amp; III)</td>
<td>Not tested (Based on results of hypotheses I, II &amp; III)</td>
</tr>
<tr>
<td>IX</td>
<td>Not rejected</td>
<td>Not rejected</td>
</tr>
<tr>
<td>X</td>
<td>Not rejected</td>
<td>Rejected</td>
</tr>
<tr>
<td>XI</td>
<td>Rejected (Three significantly different characteristics)</td>
<td>Rejected (Six significantly different characteristics)</td>
</tr>
<tr>
<td>XII</td>
<td>Not rejected</td>
<td>Not rejected</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This study examined the contributions of criterion referenced tests, measures of attitude toward mathematics, and student demographic characteristics as predictors of academic success in community college mathematics courses offered for underprepared students. Until 1968, little attention was given to the programs, needs and progress of the underprepared college students. Expansion of the civil rights movement, and, more recently, affirmative action legislation, has given increased impetus to society's demand for readily available and accessible educational opportunity for all United States citizens. The open door philosophy of the community college has made this institution the recipient of a large number of non-traditional students -- students often in need of remedial work in the basic skills of reading, writing and mathematics. The expected future growth in number of non-traditional college students, coupled with a parallel decrease in the number of traditional college students, will cause the remedial function of the community college to take a more significant share of future community college curricula. Although remedial work is beginning to be an accepted function of the community college, extensive research has not been undertaken in this area.

Literally thousands of studies have been done attempting to predict academic success. These studies, however, have dealt almost
exclusively with the traditional student and have used as predictor variables information not readily available for the non-traditional students. Attrition rates in remedial courses are very high. The ability to identify, at the outset of a course, the predicted nonsuccessful students, and create for them a program to fit their individual needs, could reduce the attrition rate and lead to greater accountability on the part of both student and institution.

Purpose of the Study

This research was undertaken to add to the knowledge base concerning remedial education in mathematics and to develop a tool to be used in improving remedial instruction. The study was concerned with predicting success in mathematics for underprepared community college students. The purpose of the study was to determine the collective contribution of five predictors: criterion referenced test scores, attitude measures, race, sex and age, as they relate to academic achievement. Other aspects of this research studied:

1) The interaction effect of race, age or sex and attitude on academic achievement.

2) Differences in predictability based on race, age and sex.

3) Change in student attitudes during the semester.

4) The relationship of attitude change and academic achievement.

5) A comparison of student demographic characteristics between:
   a) underprepared mathematics students and the total school population, and
   b) successful and nonsuccessful underprepared mathematics students.
Summary of Procedures

The population was composed of 126 students enrolled in two levels of mathematics offered for underprepared community college students at Lake Michigan College during the spring semester, 1978. As there are degrees of academic achievement, so there are also degrees of underpreparedness. The small amount of research that has been done using this type of student population, has consistently grouped all underprepared students into one population. This study attempted to determine if the heterogeneity of the population could be decreased by division into two levels of underpreparedness.

Past research has indicated that a combination of measures of intellective and non-intellective student traits accounts for the greatest amount of variance in academic success. The predictor variables chosen for this study were those measures that were readily available to the community college instructor or counselor for each underprepared student. Past academic achievement was measured by a criterion referenced screening test, normally administered to each mathematics student at the beginning of a course. Non-intellective traits can be thought of as cumulating in an expression of attitude. The widely used and easily administered Aiken-Dreger Revised Math Attitude Scale was used as the second predictor variable. A measure of attitude was taken at the beginning and again at the end of the semester. Student Registration Form A was completed by each LMC student as part of the normal college enrollment procedure. Demographic data on all students enrolled in both levels of underprepared mathematics courses, Basic Mathematics and Intermediate Algebra, was collected from these forms.

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Based on statistical analyses, twelve experimental hypotheses at the two levels of mathematics were tested:

Hypothesis I — An interaction effect does not exist between race, attitude and academic achievement for students enrolled in Basic Mathematics or Intermediate Algebra.

Hypothesis II — An interaction effect does not exist between sex, attitude and academic achievement for students enrolled in Basic Mathematics or Intermediate Algebra.

Hypothesis III — An interaction effect does not exist between age, attitude and academic achievement for students enrolled in Basic Mathematics or Intermediate Algebra.

Hypothesis IV — A predictive equation based on criterion referenced test score, a measure of attitude toward mathematics, and certain demographic characteristics, will not predict academic achievement in Basic Mathematics or Intermediate Algebra as well as past research findings.

Hypothesis V — The prediction equations generated will not be valid when applied to a similar group of Basic Mathematics or Intermediate Algebra students.

Hypothesis VI — There is no difference in predictability in Basic Mathematics or Intermediate Algebra based on race.

Hypothesis VII — There is no difference in predictability in Basic Mathematics or Intermediate Algebra based on sex.

Hypothesis VIII — There is no difference in predictability in Basic Mathematics or Intermediate Algebra based on age.

Hypothesis IX — Students enrolled in Basic Mathematics or Intermediate Algebra do not experience an attitude change during the semester.

Hypothesis X — Attitude change is not directly related to academic achievement in Basic Mathematics or Intermediate Algebra.

Hypothesis XI — Students enrolled in Basic Mathematics or Intermediate Algebra possess demographic characteristics which are the same as the total school population's demographic characteristics.

Hypothesis XII — There is no difference in the demographic characteristics of successful and nonsuccessful Basic Mathematics or Intermediate Algebra students.
The statistical procedures to test the twelve experimental hypotheses are described fully in Chapter III. In summary, the Statistical Package for the Social Sciences (SPSS) and Western Michigan University's PDP10 computer facilities were used with the following subprograms: two-way ANOVA, multi-variant regression, correlated t-test, correlation, and chi-square.

Findings

The Basic Mathematics population was composed of a majority of females (61 percent), a large proportion of non-whites (44 percent), and a slight majority of older students (57 percent). The Intermediate Algebra population was composed of a large majority of males (73 percent), a small proportion of non-whites (7 percent), and a large majority of college age students (80 percent). Statistical findings are as follows:

Demographic characteristics

A comparison of nine demographic characteristics between Basic Mathematics students and the total school population (hypothesis XI) found that Basic Mathematics students differed significantly on three traits: 1) Family income; 2) Person who had the most influence on the student attending LMC, and 3) Hours employed. In a comparison of the same nine demographic characteristics between Intermediate Algebra students and the total school population, it was found that Intermediate Algebra students differed significantly on six traits. Five of the six trait-differences were not the same.
trait-differences possessed by the Basic Mathematics group. The one
trait on which both underprepared mathematics groups had a common
difference was hours employed. The six significant trait-differences
held by the Intermediate Algebra students were: 1) Residence; 2)
Father's education; 3) Mother's education; 4) Future plans; 5) Reason
for attending LMC, and 6) Hours employed.

A comparison of fifteen demographic characteristics between
successful and nonsuccessful Basic Mathematics and Intermediate Algebra
students (hypothesis XII) was made to determine if these traits could
distinguish between the groups. No significant difference was found
on any tested trait.

It would appear that, although the Basic Mathematics and Inter­
mediate Algebra students differ on a variety of characteristics when
compared to the total population, the successful and nonsuccessful
students in each group did not possess different demographic
characteristics from one another.

Attitude

Similarity in the mean of the pre-semester attitude measure was
one constant variable between the two groups of mathematics students
studied. It appeared that the underprepared mathematics students
possessed the same attitudes toward mathematics as they began the
course, no matter what their level of underpreparedness. Attitudes
toward mathematics became more positive for both levels of
mathematics students during the semester (hypothesis IX); a gain
of 2.57 points in the mean of the attitude score of Basic Mathematics

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students and a gain of 3.39 points in the Intermediate Algebra group was found. At the .05 level the gains were not significant. However, the gains would have been significant if the .10 level had been chosen. The relationship of attitude change to academic achievement (hypothesis X) was found to be significant at the higher level, Intermediate Algebra, but not significant at the lower level, Basic Mathematics.

**Interactions and prediction equations**

An interaction effect (hypotheses I, II, and III) was found in only one instance, at the Basic Mathematics level between race and attitude on academic achievement. Due to the lack of interaction based on sex or age and attitude, hypotheses VII and VIII were not tested. On the basis of the significant interaction between race and attitude found at the lower level mathematics course, two separate regression equations were generated for Basic Mathematics based on race (hypothesis VI). Criterion referenced screening test score and measure of attitude toward mathematics were used as the independent variables to predict academic achievement. It was found that the White group was more predictable than the non-white group. The equation generated accounted for 27 percent and 14 percent, respectively, of the variance in academic achievement.

Total group prediction equations based on criterion referenced screening test scores, attitude toward mathematics, race, sex, and age were generated for Basic Mathematics and Intermediate Algebra (hypothesis IV). The Basic Mathematics prediction equation was:
\[ Y' = 7.60259 + (0.17646 \times \text{Screening test score}) + (0.01411 \times \text{Attitude score}) + (0.22192 \times \text{Age}) - (0.93152 \times \text{Sex}) - (0.44818 \times \text{Race}) \]

and accounted for approximately 31 percent of the variance in academic achievement \((R = 0.5551)\). The Intermediate Algebra prediction equation was:

\[ Y' = 26.92332 + (0.29066 \times \text{Screening test score}) + (0.19734 \times \text{Attitude score}) - (0.81859 \times \text{Age}) + (8.34536 \times \text{Sex}) + (23.86962 \times \text{Race}) \]

and accounted for approximately 42 percent of the variance in academic achievement \((R = 0.64942)\). As had been suggested by Astin (1971), students in the higher level of mathematics were found to be more predictable than students in the lower level course.

The prediction equations, when applied to similar groups of Basic Mathematics and Intermediate Algebra students (hypothesis V), were found to be valid. The Basic Mathematics prediction equation differentiated between successful and nonsuccessful students, 78 percent of the time, while the Intermediate Algebra prediction equation correctly classified successful and nonsuccessful students 64 percent of the time.

Implications and Conclusions

**Demographic characteristics**

Basic Mathematics students differed from the total school population on the basis of family income, hours employed and the person who influenced their attendance at LMC. The characteristics held by the Basic Mathematics group would seem to define this group as non-traditional. A large segment came from low socioeconomic backgrounds, the group had a large number of minority students and tended to be
older than normal college age. The large proportion who were unemployed may indicate that the inability to find meaningful work had led these students to choose the option of attending college. Grants and other financial aid are readily available based on financial need. This, also, may have been a factor in the decision of these non-traditional students to attend college. The Basic Mathematics group was significantly more influenced by counselors and friends than the total college population. This might imply a more recent decision to attend college. The traditional group was more likely to have had long standing expectations of going on to college.

Intermediate Algebra students differed from the total school population on the basis of six traits and would appear to be a traditional four-year college group. They were likely to live at home and be of normal college age. Their parents had more formal education and probably had instilled the expectation of attending college in these students. Future plans and reasons for attending for both the Intermediate Algebra students and the total population indicated that the students planned to transfer and to attempt to complete a baccalaureate degree. Generally, both groups were traditional in that they contributed a portion of their college expenses through part-time employment. The question arises, why were Intermediate Algebra students, who fit the traditional mold, not academically ready to start at the college level of mathematics? Two reasons are suggested:

1) It has been speculated that the Intermediate Algebra group was
composed of the type of student one would expect to find attending a four-year college or university. However, during high school these community college students may not have chosen the 'tough' mathematics courses, not realizing the need for these proficiencies in the college curriculum. Career options were limited by this omission. The community college may be providing a place where the traditional students can develop their academic proficiencies to college level. Therefore, it can be expected that this group will transfer as soon as their academic deficiencies are remediated.

2) Cost is becoming a more significant factor in attending college. As was suggested, the Intermediate Algebra group shares many of the characteristics of students who attend four-year colleges and universities. It could be that in this day of inflation and rising academic cost, economics have mandated that the more traditional students spend a year or two at the community college before transfer to a baccalaureate granting institution. If this is the trend, the community college can expect an increase in this type of traditional student.

It has been anticipated that if demographic characteristics could distinguish between levels of mathematical attainment, they would also distinguish between success and nonsuccess in a mathematics course. This was not the case for students in either level of mathematics.

The two levels of underprepared mathematics students were more different than similar. It appeared that two distinctly different populations were being tested. Demographic characteristics were a component of determining what level a student had reached and which
class they should take. However, once enrolled in the class, these same characteristics did not determine who would or would not succeed in that group.

**Attitude**

Attitude did not prove to hold the significance indicated by past research. Student attitudes at both levels were approximately the same at the beginning of the courses. Both groups reported a small change in attitude in a positive direction during the semester, however, these changes were not significant.

In the Basic Mathematics group, attitude change was not related to academic achievement. It could be speculated that, with lower level, non-traditional mathematics students, instructors should devote their time and attention to academic learning and disregard attitudes. Another consideration could be that the mathematical underpreparedness of these students was so great that it masked the effect of attitude. It also should be understood that a measure of attitude is a cumulation of thirteen years of past educational experience. The lower level underprepared students had, undoubtedly, experienced past failure in mathematics. A significant change, probably, should not have been expected during only one semester of time.

The next level of mathematics, Intermediate Algebra, did show a significant relationship between academic achievement and attitude change. The filter effect may have taken place here. The less mathematically talented students may not have elected to proceed with their mathematical education. At the Intermediate Algebra level
student mathematical deficiencies had been partially remediated or were not as great. Their underpreparedness was not as strong and therefore, was not masking the part attitude plays in academic achievement.

Attitudes towards mathematics held by very underprepared community college students do not have a significant effect upon their academic achievement. As student mathematical deficiencies become remediated, attitude changes become related to academic achievement.

**Prediction equations**

The prediction equations generated based on criterion referenced test scores, attitude, age, sex and race, were found to be valid. The equations correctly identified the successful and nonsuccessful students at both mathematical levels. It is important that it be kept in mind that these equations used criterion referenced test scores as one of the predictors. As criterion referenced tests become more available for all subject areas, the need for standardized norm-referenced testing procedures will be questioned. The recent shifts in teaching methodology, particularly at the remedial level, have made criterion referenced test results readily available. Using these tests as a tool to predict academic performance may be a feasible solution for student success identification. Educators have been trained to expect that high school grades or standardized test results are needed in order to do a valid predictive study. It then follows that if these measures are not available, a valid predictive equation cannot be developed. The results of this study have shown that criterion referenced test measures are as predictive as standardized testing procedure results.
Criterion referenced test scores are as accurate an intellective predictor as norm-referenced standardized test scores. Criterion referenced tests should be used not only for their instructional decision making ability but also for their predictive ability.

Summary and Recommendations for Future Research

Remedial courses at the college level are increasingly being taught under some type of behavioral system approach to instruction. The self-paced, individualized facet of the systems approach lends itself well towards compensating for the problems caused by the diversity of the underprepared student population. Criterion referenced testing is an integral part of the systems approach.

Underprepared students, and their instructors, probably have a greater need to be informed of their success potential in college than the more traditional students in 'normal' college programs given the high failure and attrition rate among underprepared students. Yet, little research has been done on this increasingly large segment of the college population. Any tool that can easily and readily identify the potential nonsuccessful student will be an instructional asset.

Past predictive studies have used traditional students and traditional intellective variables (such as high school grade or standardized test results). That information is often not available on remedial community college students. This research used non-traditional students and criterion referenced test results as the intellective variable measure. Criterion referenced test results
were found to be as accurate an intellective predictor as the high school grades or standardized test results used in past studies. The combination of predictors — criterion referenced test, attitude measure, race, age, and sex — accounted for approximately the same amount of variance in academic achievement as has been found in past predictive research. This study developed a model for identification of successful and nonsuccessful underprepared mathematics students. It appears that a criterion referenced test, tightly keyed to course objectives, and coupled with an easily administered attitude test, can predict outcome as well as lengthy and involved standardized tests. This study was confined to one community college and covered one semester of time. The constancy of the results will only be verified by replication.

The findings of this research have added to the knowledge base concerning remedial mathematics students. As the students approached the level of college mathematics, as their underpreparedness was remediated, they became more like the student populations found in past research. Attitude became more of a factor in academic achievement and student demographic characteristics became more traditional. The group in need of the most remediation was found to be the group most unlike the student populations used in past research.

Underprepared college students are different and further research is needed to delineate those differences. This study divided students into two levels of underpreparedness. The lower level, Basic Mathematics, possessed many different traits and
patterns. Additional studies should be done subgrouping these kinds of students into many levels of underpreparedness. Specific influences, changes and traits might become more clear. This study may have masked those characteristics by grouping all levels of underpreparedness below Algebra into one population.

The five predictor variables used in this study were found to be valid and differentiated between successful and nonsuccessful underprepared community college mathematics students. An additional area for further research would be to apply these predictors to other subject areas and other student populations.
REFERENCES


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Henson, R. Expectancy beliefs, ability and personality in predicting academic performance. Journal of Educational Research, 1976, 70, 41-44.


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1. What is another name for the number represented by 60000 + 40 + 7?
   a. 647  
   b. 6047  
   c. 6470  
   d. 60047

2. What is the number for six million?
   a. 60,000  
   b. 600,000  
   c. 6,000,000  
   d. 60,000,000

3. Round 3978 to the nearest ten.
   a. 3000  
   b. 3900  
   c. 3980  
   d. 4000

4. Divide 76443 by 249.
   a. 37  
   b. 307  
   c. 3007  
   d. none of these

5. Subtract 2388 from 4976.
   a. 2588  
   b. 3588  
   c. 3612  
   d. 3688

6. $2^5$ is another name for ____.
   a. 32  
   b. 16  
   c. 12  
   d. 10

7. Write 1,000 as a power of 10.
   a. $10^0$  
   b. $10^3$  
   c. $10^4$  
   d. $10^5$

8. Which of the following numbers can be divided evenly by 3?
   a. 4333  
   b. 6016  
   c. 2371  
   d. 6303
9. Add: \[ \frac{12}{3} + \frac{35}{6} \]
   - a. \[ \frac{47}{9} \]
   - b. \[ \frac{41}{3} \]
   - c. \[ \frac{51}{2} \]
   - d. \[ \frac{51}{6} \]

13. Subtract \( 2 \frac{3}{4} \) from \( 5 \frac{1}{3} \)
   - a. \( \frac{15}{12} \)
   - b. \( \frac{27}{12} \)
   - c. \( \frac{21}{4} \)
   - d. \( \frac{25}{12} \)

10. What is the least common denominator for \( \frac{1}{12} \) and \( \frac{1}{8} \)?
   - a. 24
   - b. 12
   - c. 8
   - d. 4

14. \( 8 \div 12 = \) ___.
   - a. \( \frac{3}{4} \)
   - b. \( \frac{3}{4} \)
   - c. \( \frac{2}{3} \)
   - d. none of these

11. Which is the least of these fractional numbers?
   - a. \( \frac{5}{17} \)
   - b. \( \frac{1}{3} \)
   - c. \( \frac{3}{11} \)
   - d. \( \frac{1}{4} \)

15. \( \frac{2}{3} \times \frac{31}{4} = \) ___.
   - a. \( \frac{1}{2} \)
   - b. \( \frac{8}{27} \)
   - c. \( \frac{21}{6} \)
   - d. \( \frac{33}{8} \)

12. Subtract \( 2 \frac{5}{6} \) from 8.
   - a. \( 4 \frac{5}{6} \)
   - b. \( 5 \frac{5}{6} \)
   - c. \( 5 \frac{1}{6} \)
   - d. \( 4 \frac{1}{6} \)

16. \( 1 \frac{3}{4} \div \frac{11}{6} = \) ___.
   - a. \( 14 \frac{17}{1} \)
   - b. \( \frac{11}{2} \)
   - c. \( \frac{119}{2} \)
   - d. none of these
17. Which names the greatest number?
   a. 0.763
   b. 3
   c. 0.756
   d. .7631

21. Subtract .4 from 1.28.
   a. 1.24
   b. 12.4
   c. 1.32
   d. 0.88

18. Round 3.0086 to the nearest thousandth.
   a. 3.009
   b. 3.01
   c. 3.10
   d. 3.010

22. Multiply: 3.2 x .08
   a. 0.0256
   b. 0.256
   c. 2.56
   d. 25.6

19. Which of the following is six thousandths?
   a. .05
   b. .5
   c. 2
   d. 20

23. Divide .8 by .04.
   a. .05
   b. .5
   c. 2
   d. 20

20. Add: 1.34 + 10.3
   a. .234
   b. 2.34
   c. 11.64
   d. 13.7

24. Divide: .63|2.142
   a. .34
   b. 3.4
   c. 34
   d. none of these
25. Which of the following is not a proportion?
   a. 3:4 = 6:8
   b. \( \frac{2}{3} = \frac{1}{1.5} \)
   c. 2 x 4 = 4 x 2
   d. \( \frac{1}{2} = \frac{4}{8} \)

26. If a class has 10 girls and 15 boys, what is the ratio of girls to boys?
   a. \( \frac{2}{3} \)
   b. \( \frac{3}{2} \)
   c. \( \frac{3}{5} \)
   d. \( \frac{2}{5} \)

27. The ratio of \( \frac{1}{2} \) to \( \frac{3}{2} \) is equivalent to the ratio of _______.
   a. 2 to 3
   b. 1 to 3
   c. 1 to 6
   d. 3 to 4

28. The ratio of 16 to 48 is equivalent to the ratio of _______.
   a. 1 to 3
   b. 4 to 9
   c. 7 to 9
   d. 36 to 16

29. The ratio of .8 to .04 is equivalent to the ratio of _______.
   a. 20 to 1
   b. 1 to 20
   c. 1 to 2
   d. 2 to 1

30. The ratio of \( \frac{2}{3} \) to \( \frac{3}{4} \) is equivalent to the ratio of _______.
   a. 2 to 3
   b. 3 to 2
   c. 5 to 7
   d. 21 to 31

31. Solve the following proportion for x:
   \( \frac{3}{5} = \frac{x}{7} \)
   a. \( x = \frac{41}{5} \)
   b. \( x = 6 \)
   c. \( x = \frac{51}{4} \)
   d. \( x = 5 \)

32. Divide 12 inches into two parts which are in the ratio of 3 to 4.
   a. 5 in. and 7 in.
   b. \( \frac{51}{7} \) in. and \( \frac{66}{7} \) in.
   c. \( \frac{44}{5} \) in. and \( \frac{71}{5} \) in.
   d. \( \frac{81}{3} \) in. and \( \frac{32}{3} \) in.
33. 1 is what percent of 400?
   a. .25%
   b. 4%
   c. 2 \( \frac{1}{2} \) %
   d. 40%

34. Write 0.0027 as a percent.
   a. 0.027%
   b. 2.7%
   c. 27%
   d. none of these

35. To find \( \frac{16}{3} \) of a number, you multiply the number by _____.
   a. \( \frac{50}{3} \)
   b. \( \frac{3}{50} \)
   c. \( \frac{1}{6} \)
   d. \( \frac{1}{8} \)

36. 12 \( \frac{1}{2} \) % written as a decimal number is _____.
   a. 12.5
   b. 1.25
   c. .125
   d. .0125

37. \( \frac{1}{2} \) % of 9 is _____.
   a. 1.8
   b. .18
   c. .45
   d. .045

38. \( \frac{7}{8} \) written in percent notation is _____.
   a. 67 \( \frac{1}{2} \)
   b. 78%
   c. 92%
   d. none of these

39. 3.6% of 50.4 is _____.
   a. 18.144
   b. 1.8144
   c. 1.400
   d. .1400

40. 250% of 80 is _____.
   a. 20
   b. 32
   c. 200
   d. 320
41. If you add the measure of the angles of a triangle, what is the total?
   a. 180 degrees
   b. 90 degrees
   c. 360 degrees
   d. it depends on the triangle

42. If the radius of a circle is 1.5, what is its diameter?
   a. .75
   b. 1.5
   c. 2.25
   d. 3.0

43. If the radius of a circle is 7 inches, what is its area in square inches? (Use \( \frac{22}{7} \) for \( \pi \))
   a. 154
   b. 144
   c. 44
   d. 22

44. What is the perimeter in feet of a rectangle that is 4 feet wide and 9 feet long?
   a. 13 feet
   b. 16 feet
   c. 26 feet
   d. 36 feet

45. If the diameter of a circle is 8, what is its circumference?
   a. \( 2\pi \)
   b. \( 4\pi \)
   c. \( 8\pi \)
   d. \( 16\pi \)

46. If the length of a rectangle is 15 inches and its width is 1 foot, what is its area in square feet?
   a. 1.5 sq. feet
   b. 15 sq. feet
   c. 180 sq. feet
   d. 1.25 sq. feet

47. The area of this figure is ______.
   ![Diagram](image)
   a. 14 sq. units
   b. 24 sq. units
   c. 40 sq. units
   d. 48 sq. units

48. Which of the following is the formula for the area of a triangle?
   a. \( A = \pi r^2 \)
   b. \( A = \frac{1}{2} h \times (b_1 + b_2) \)
   c. \( A = \frac{1}{2} bh \)
   d. \( A = \frac{1}{2} w \)
MATH 101 PLACEMENT EXAM: FORM C

Name______________________________________ Soc. Sec. No.________
Date__________________ Class Name____________________ Class Time________

PROBLEM

1. Simplify as far as possible

   a. \(\frac{126}{168} = \)

   b. \(\frac{12}{(-3)} = \)

   c. \(6 - 13 = \)

   d. \(\frac{4}{9} + \frac{3}{5} = \)

   e. \((-4)(-5) = \)

   f. \(\frac{4}{21} \div \frac{12}{35} = \)

   g. \(6 - (-4) = \)

   h. \((\sqrt{2} + \sqrt{5})^2 = \)

   i. \(\frac{1}{4} + \frac{1}{3} = \)

   j. \(\frac{6}{7} \div \frac{4}{3} = \)

   l. \(\)
<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>ANSWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Factor</td>
<td>2.</td>
</tr>
<tr>
<td>a. $6x^2 - 3x =$</td>
<td>a.</td>
</tr>
<tr>
<td>b. $x^2 - 2x + 1 =$</td>
<td>b.</td>
</tr>
<tr>
<td>c. $x^2 - 9 =$</td>
<td>c.</td>
</tr>
<tr>
<td>3. Solve for $x$:</td>
<td>3.</td>
</tr>
<tr>
<td>a. $2x - 9 = 5x - 15$</td>
<td>a.</td>
</tr>
<tr>
<td>b. $3x - 1 = 0$</td>
<td>b.</td>
</tr>
<tr>
<td>c. $x^2 + 1 = 5$</td>
<td>c.</td>
</tr>
<tr>
<td>a. $\sqrt{9 + 16} =$</td>
<td>a.</td>
</tr>
<tr>
<td>b. Let $x = 3$; then</td>
<td>b.</td>
</tr>
<tr>
<td>$x^2 - 4x + 5 =$</td>
<td>c.</td>
</tr>
<tr>
<td>c. $4^3 - 2^3 =$</td>
<td>c.</td>
</tr>
<tr>
<td>d. $\frac{12}{\left(\frac{3}{4}\right)} =$</td>
<td>d.</td>
</tr>
<tr>
<td>Statement</td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>1. I am always under a terrible strain in a math class.</td>
<td>SD</td>
</tr>
<tr>
<td>2. I do not like mathematics, and it scares me to have to take it.</td>
<td>SD</td>
</tr>
<tr>
<td>3. Mathematics is very interesting to me, and I enjoy math courses.</td>
<td>SD</td>
</tr>
<tr>
<td>4. Mathematics is fascinating and fun.</td>
<td>SD</td>
</tr>
<tr>
<td>5. Mathematics makes me feel secure, and at the same time it is</td>
<td>SD</td>
</tr>
<tr>
<td>stimulating.</td>
<td></td>
</tr>
<tr>
<td>6. My mind goes blank, and I am unable to think clearly when</td>
<td>SD</td>
</tr>
<tr>
<td>working math.</td>
<td></td>
</tr>
<tr>
<td>7. I feel a sense of insecurity when attempting mathematics.</td>
<td>SD</td>
</tr>
<tr>
<td>8. Mathematics makes me feel uncomfortable, restless, irritable, and</td>
<td>SD</td>
</tr>
<tr>
<td>impatient.</td>
<td></td>
</tr>
<tr>
<td>9. The feeling that I have toward mathematics is a good feeling.</td>
<td>SD</td>
</tr>
<tr>
<td>10. Mathematics makes me feel as though I'm lost in a jungle of</td>
<td>SD</td>
</tr>
<tr>
<td>numbers and can't find my way out.</td>
<td></td>
</tr>
<tr>
<td>11. Mathematics is something which I enjoy a great deal.</td>
<td>SD</td>
</tr>
<tr>
<td>12. When I hear the word math, I have a feeling of dislike.</td>
<td>SD</td>
</tr>
<tr>
<td>13. I approach math with a feeling of hesitation, resulting from</td>
<td>SD</td>
</tr>
<tr>
<td>a fear of not being able to do math.</td>
<td></td>
</tr>
<tr>
<td>14. I really like mathematics.</td>
<td>SD</td>
</tr>
<tr>
<td>15. Mathematics is a course in school which I have always enjoyed</td>
<td>SD</td>
</tr>
<tr>
<td>studying.</td>
<td></td>
</tr>
<tr>
<td>16. It makes me nervous to even think about having to do a math problem.</td>
<td>SD</td>
</tr>
<tr>
<td>17. I have never liked math, and it is my most dreaded subject.</td>
<td>SD</td>
</tr>
<tr>
<td>18. I am happier in a math class than in any other class.</td>
<td>SD</td>
</tr>
<tr>
<td>19. I feel at ease in mathematics, and I like it very much.</td>
<td>SD</td>
</tr>
<tr>
<td>20. I feel a definite positive reaction to mathematics: it's</td>
<td>SD</td>
</tr>
<tr>
<td>enjoyable.</td>
<td></td>
</tr>
</tbody>
</table>

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**GRADING CRITERIA**

Your grade will depend on how much of the material listed below you complete in one semester. The brackets show what material must be completed to earn the grade listed next to the bracket.

**BASIC MATH - 090**

- Unit 1 - Subunit 1.1
  - 1.2
  - 1.3
  - 1.4
  - **D-090**

- Unit 2 - Subunit 2.1
  - 2.2
  - 2.3
  - **C-090 with 60 hours of lab time**

- Unit 3 - Subunit 3.1
  - 3.2

- Unit 4 - Subunit 4.1
  - 4.2

- Unit 5 - Subunit 5.1
  - 5.2
  - 5.3

- Unit 6 - Subunit 6.1
  - 6.2

**POSTPROGRAM TEST**

- **C-090**

**Elementary or Business Algebra**

- **Module 1** Section 1
- **Module 2** Section 2
- **Module 3** Section 3
- **Module 4** Section 4
- **Module 5** Section 5
- **Module 6** Section 6
- **Module 7** Section 7
- **Module 8** Section 8
- **Module 9** Section 9
- **Module 10** Section 10 - Final test covering all 10 Sections
- **Module 11**
- **Module 12** - Final test covering all 12 Modules (See instructor for grading criteria.)