VARIABLES THAT CORRELATE WITH SUCCESS IN FIRST YEAR ALGEBRA

By

Brenda Lee Sargent

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APPROVED:

Ronald McKeen, Co-Chairman

Jimmie Fortune, Co-Chairman

Kenneth E. Underwood

Wayne M. Worner

William D. Griffith

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ABSTRACT

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Brenda Lee Sargent

Committee Co-Chairmen: Dr. Jimmie C. Fortune
Dr. Ronald McKeen

Educational Administration

First-year algebra is a course that has a high failure rate and because of this it has been a source of concern for educators, parents, and students. The regular algebra course and the decelerated algebra course have been the focus of attention regarding the placement of high school students.

The purpose of this research study was to examine several available predictors in concert with early indicators of algebra performance to see if ensuing achievement in algebra could be predicted accurately. Four different criteria measuring layered achievement in algebra were used. Nine predictor variables were examined in various combinations. The predictors were: Algebra Prognosis Test, Study Habits, Previous Course, Previous

Course Grade, SRA Math Concepts, SRA Math Computation, SRA Reading, SRA Composite, and First Nine Weeks' Algebra Grade.

The study found that adequate and promising predictions can be made using combinations of the predictor variables. From these predictors, discriminant function equations were derived and placement into algebra from the use of these discriminant function equations was recommended.

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CHAPTER I

INTRODUCTION

First year algebra is a high school course in which many students experience failure. School administrators and teachers are aware that many factors influence algebra achievement. Researchers report that some of these factors are school related whereas others are non-school related (Coleman and others, 1966; Matthews and Brown, 1976; Good, Biddle, and Brophy, 1976; Carrier, 1981). Educators have recommended that many school-related factors be examined as to their affect on achievement. Researchers have investigated the role of textbooks, teachers, fiscal expenditures, and many other factors to assess their influence on achievement. However, one overlooked source as to its influence on student achievement may be the school scheduling (placement) process itself.

Misplacement of students in a particular course may affect their achievement. The high rate of unsuccessful achievement in the first year algebra course suggests a need to identify variables that can be used in placement procedures. These variables should provide some indication as to which students can be expected to be successful in achieving the goals (objectives) of algebra and which students can be expected to be unsuccessful. If this can be accomplished, the placement procedure itself will help to alleviate the high failure rate and many of the administrative problems involved in rescheduling unsuccessful algebra students.

Concerns of Administrators

Due to the lack of successful performance in algebra, school administrators face many problems with the community and staff. When the first official report card goes home, many parents of unsuccessful algebra students demand schedule changes. Lower level mathematics classes start to increase in size and the administrator hopes that she/he anticipated the magnitude of the problem correctly when designing the master schedule the previous spring. Hopefully, these unsuccessful algebra students will be able to be rescheduled without exceeding the limits established on other class sizes or teacher loads.

As the second report cards are distributed, more rescheduling occurs and sometimes algebra classes are consolidated to provide room for a new section of pre-algebra. New student schedules and teacher assignments must be made to accommodate the situation. Much time and many resources are expended during this process.

Placement Procedures as a Variable That Relates to Achievement in Mathematics

Many school administrators and teachers are concerned about the first year algebra program. The school system in which the researcher worked had schools that were experiencing as high as a forty percent rate of D's and F's in its first year algebra program. In a national study, Carpenter (1982) found that, even when students had completed two years of algebra and a year of geometry, student performance had not reached the point of mastery. This study, Student Performance in Algebra: Results From the National Assessment (1982), indicates that if the inclusion of more concrete examples and the use of developmental activities do not improve student performance noticeably, we may be forced to conclude that algebraic concepts are too difficult for many students at the freshman level of their education. If true, postponement of formal reasoning might be best for these students.

This present situation has been compounded by the tremendous popularization of the secondary school. The number of students graduating from high school and attending college has increased dramatically since the turn of the century. The age of information has made the field of technology explode. Computers are becoming a part of the home. The demand for an algebra credit increases and so do the number of students enrolled in first year algebra.

Many students may not be ready for first year algebra in the ninth grade. However, it is public education and students have been granted the right to attempt this rigorous course if they so elect. This selection of algebra by students who are not ready could contribute to the high failure rate in first year algebra.

Callicutt (1961) states that during the freshman year of high school, the selection of courses determines a student's course of action for her/his entire high school years. Dykes (1980) feels that, even at the college level, students should be assisted in course selection. He believes that choosing the course that will offer a student a potentially successful learning experience is important. "This (selection process) is important because some level of competency in mathematics is required for a majority of students to reach their academic goals" (Dykes, 1980, p. 3). Begle (1976) reports that many studies have concentrated on the selection process and ways of improving it. In particular, Begle points out that much research has been conducted relating to the problem of predicting success in algebra.

Predicting Algebra Achievement

Many variables have been investigated to establish their relationship to first year algebra achievement. Hanna, Bligh, Lenke and Orleans (1969) found that eighth grade averages were statistically significant in predicting success in algebra. In a similar study, Mogull and Rosengarten (1972) found that eighth grade mathematics averages were statistically superior to more objective and elaborate devices such as the Iowa Algebra Aptitude Test and the Differential Aptitude Test in predicting such in first year algebra. Ivanoff, DeWane, and Praem (1965) used six predictor variables in their study. They were: four subtests of the SRA test, I.Q. rating, and eighth grade mathematics grade. These researchers found the SRA composite score to be the single best predictor of ninth grade first year algebra success.

Mogull and Rosengarten, Jr. (1974) stated that "in counselling eighth grade students who are about to enter high school, guidance counselors and teachers might find useful a valid method of predicting student success in elementary algebra" (p. 34). If easily accessible and available predictor variables could be identified, a placement procedure could be implemented based on these to counsel students in their selection of algebra. This could assist in alleviating the high failure rate.

Statement of the Problem

The high failure rate in first year algebra classes has caused much concern. Placement procedures is an area that needs to be investigated. The problem is that there needs to be a better placement procedure because of the consequences of the one in place--a forty percent unsuccessful achievement rate in algebra in the school in which the study was conducted.

Misplacement of students can result in two basic problems. First, there are scheduling problems that occur. The unsuccessful student needs to be reassigned. The administrator must maintain proper teacher-pupil ratios. New sections of particular classes need to be created, whereas some existing sections need to be dissolved. Teachers are given new teaching assignments and counselors devote many hours to redoing student schedules. The result being that much time and money has been expended. Perhaps better placement procedures would help to reduce this inappropriate waste of temporal and financial resources.

The second problem that misplacement of students causes is that students are put into inappropriate environments for learning or achieving. In order to improve the learner's opportunities to succeed, perhaps better predictors of successful achievement are necessary. Perhaps by identifying better predictor variables of algebra achievement, the placement procedure would become more efficient and students would be more appropriately placed.

Purpose of the Study

The purpose of this study was to investigate the relationships that might exist between selected variables and achievement of first year algebra students. There were two prediction questions that were addressed. They are:

1. What are the predictor variables, alone or in some combination, that would assist in identifying those students who would be most likely to succeed or fail in achieving the objectives of first year algebra?

2. Can the first nine weeks algebra grade predict successful or unsuccessful achievement for the year in first year algebra?

Research Questions

This research study addressed the following three questions:

1. Is there a relationship among the eight predictor variables, teacher assigned semester algebra grade, Mid-Year Algebra Test score and Department Final Algebra Exam score?

2. Can successful or unsuccessful algebra achievement be predicted by the eight predictor variables or some combination of them when achievement is measured by:

a) Teacher Assigned Semester Grade?

b) Mid-Year Algebra Test Score?

c) Department Final Algebra Exam Score?

3. Can successful or unsuccessful algebra achievement be predicted by first nine weeks algebra grade when

achievement is measured by teacher assigned final algebra grade?

Limitations of the Study

In order that the method of identifying successful or unsuccessul algebra candidates not become so complicated a procedure as to make it impractical to employ, the researcher limited herself to an examination of the following predictors:

1. SRA Composite Score (Eighth Grade).
2. SRA Math Concepts (Eighth Grade).
3. SRA Math Computation (Eighth Grade).
4. SRA Reading Comprehension (Eighth Grade).
5. Algebra Aptitude (as measured by Orleans-Hanna Score).
6. Previous Year's Math Grade.
7. Previous Year's Math Course.
8. Study Habits.

Realizing that many variables influence achievement, the researcher chose the aforementioned variables due to availability and practicality. The study habits variable is a limitation inasmuch as it was administered at the conclusion of the third nine weeks.

Teaching methods at the schools selected were not controlled for, or a part of, the study. Textbooks used by all teachers were the same.

Generalizations from the results of this study should be limited to other schools and districts with similar populations and conditions. The study involved ten first year algebra classes in one secondary school that was located in a large suburban area.

Basic Assumptions of the Study

The study was based on the assumption that the successful algebra student can be defined by use of:

1. Teacher assigned semester average.
2. Mid-Year Algebra Test score.
3. Department final examination score.
4. Final algebra grade.

The study was based on the assumption that educators should endeavor to provide students with as many successful learning experiences and growth opportunities as possible.

Significance of the Study

Mehlhorn (1981) explains that "simple criteria which predict success in Algebra I for the purpose of proper placement of students into the freshman high school mathematics program has plagued teachers, counselors, students, and parents for many decades" (p. 7). To establish if information, that is currently available and easily accessible, can be used in predicting success or failure in first year algebra will assist school personnel in scheduling students into classes where they can perform or achieve. Thus, proper placement of high school students is of paramount importance. Perhaps if students were properly placed, successful experiences would follow. Manlove (1979, p. 5) said:

> Student learning is the fundamental reason that schools exist. After busing disputes, negotiations, hearings, and the myriad of other problems that seek resolution, the critical question which taxpayers have the right to ask and for which professional educators will be held accountable is, "What happened to students who passed this way?"

In order for students to learn, they must first be properly placed. This study is significant because it attempted to establish certain variables as predictors of successful or unsuccessful achievement in first year algebra. These variables are important because they can be utilized in developing an appropriate placement procedure for first year algebra students. The significance of this is that resources will be saved by the administration by reducing the amount of rescheduling and that students will be in appropriate environments so as to improve learner opportunities.

Definition of Terms

The SRA Test, administered by the Science Research Associates, is a battery of tests in the areas of English, mathematics, social studies, and science which measure the achievement of students in those areas. The composite score is an average of three test scores: language, mathematics and reading. The SRA achievement scores are widely used to assess achievement.

The Orleans-Hanna Prognosis Test consists of two parts. A questionnaire part is where students report their last year grades in the areas of English, mathematics, social studies and science. The fifth question on the questionnaire is where the student reports what his/her expected final algebra grade for the year will be. The second part of the test is composed of a mathematics lesson followed by problems that relate to the mathematics lesson.

Previous mathematics grade is the most recent mathematics grade that is recorded on the student's official transcript.

Previous mathematics course is the most recent mathematics course that is recorded on the student's official transcript.

Study habits score is obtained for each student on a four-item questionnaire developed by the researcher to assess algebra work habits.

Success in algebra is defined as follows. In reference to teacher assigned semester average, an average of C or better is defined to mean successful achievement. In reference to the Mid-Year Algebra Test, a score of 15 or better is defined to mean successful achievement. In reference to the final examination, a score of 64 or better is defined to mean successful achievement. In reference to final year grade, a teacher assigned final report grade of C or better is defined to mean successful achievement.

First nine weeks grade is the algebra grade that the student has been assigned based on teacher evaluation for the first nine weeks of the school year.

Final year grade is the algebra grade that the student has been assigned based on teacher evaluation for the entire school year.

Summary

The intent of Chapter One was to provide the reader with an overview of this study. The background of the problem being explored and the theoretical framework of the study were presented. The purpose of the study, the research questions, and the significance were discussed as well as the limitations of the study and basic assumptions.

The rest of the study was reported in the following manner. Chapter Two is a review of the literature. It has two major sections followed by a summary. The first section reviews literature that relates to variables that influence student achievement. The second section reviews literature that relates to the prediction of student achievement and focuses primarily on first year algebra achievement. The summary connects the two sections and the literature review.

Chapter Three explains the methodology of the study. The setting, student body, scholastic aptitude and achievement, and sequences of mathematics courses are discussed for the school in which the study was conducted. The data collection section is broken down so as to explain first about the predictor (independent) variables and then the criterion (dependent) variables. The final section of this chapter explains what procedures were used to analyze the data that were collected and what hypotheses were being tested. A summary of the chapter is provided.

Chapter Four reports the findings of this study. The results of the data analysis as indicated by the computer usage of the Statistical Package for the Social Sciences are presented.

Chapter Five is divided into two parts. Part one discusses the conclusions of the study. Part two presents some recommendations the researcher would make to potential future investigators in the same area of study.

Special Considerations

It should be mentioned that the public school system used in this study allows students who are performing well in mathematics to take first year algebra in the eighth grade. Some of its gifted and talented students are beyond algebra in the eighth grade. Also, it should be noted that high school first year algebra students are assigned to specific classes by the school guidance counselors according to overall school scheduling procedures.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study was to investigate the relationships that exist between selected variables and achievement of first year algebra students. This study proposed to identify predictor variables that would assist in distinguishing between those students who would be most likely to succeed or fail in ahieving the objectives of first year algebra. The study also examined the possibility of the first nine weeks algebra grade predicting end of the year algebra successfulness or unsuccessfulness.

This chapter reviews the literature and research and is divided into two major sections followed by a summary. The first section of the literature review relates to factors that influence student achievement in general. The second section reviews the literature with respect to prediction of achievement--specifically, with respect to variables that have been used to predict achievement in first year algebra.

Variables That Affect Student Achievement

As educators struggle to meet the modern demands of educating America's youth, the search for ways to improve school effectiveness is intensified. However, Eleanor

Farrar, Vice President of the Huron Institute, has said that, in general, school reformers have bypassed the more complicated secondary schools. She continued by saying, "consequently, there hasn't been much change in high schools, and there hasn't been much improvement" (Phi Delta Kappan, 1983, p. 445).

What then makes a school effective? According to Edmonds (1982), there are five characteristics of effective schools:

1. Strong leadership and attention to the quality of instruction by the building principal.

2. A pervasive and broadly understood instructional focus.

3. An orderly and safe climate conducive to teaching and learning.

4. Teacher expectations that all students can achieve minimum mastery.

5. Use of pupil achievement measures as a basis for program evaluation (p. 7).

Especially at this time of the renewed accountability movement, the program in which pupil achievement is low must be examined by educators in order to increase the effectiveness of the overall school program.

Much attention has been focused on public education. The media is challenging the effectiveness of schools. "Help! Teachers Can't Teach!" (1980) was an article in Time Magazine that brought attention to public education. Achievement scores are being published by local newspapers and school districts are being compared. Many laymen, as well as educators, are interested in the various factors that influence learning (Bloom, 1980).

Coleman and others (1966) decided that there are many influences on learning which education cannot alter. Matthews and Brown (1976) report:

> It may be that educators have the legitimate right to reject the charge that schools must be highly effective with all students. Students' aspirations, motivation, skills, and knowledge when they enter school are strongly affected by home and community background factors (p. 3).

Carrier (1981) conducted a study that investigated the relationship of non-school factors to achievement in reading and mathematics. The five non-school factors were: (1) absenteeism; (2) family structure; (3) Patient's Education (SES); (4) school mobility; (5) self-concept. His conclusions were:

1. A critical mass effect is present in that vocabulary and math scores deteriorate significantly after 32 or more mean absences.

2. Virtually no significant differences in achievement between groups from two parent and mother only families.

3. There are significant differences in the total sample in reading and vocabulary favoring students with parents having one or more years of college.

4. There are no significant differences in percentile achievement between any student groups with zero, one or two or more school moves. There is a tendency for report card grades to decrease slightly as mobility increases.

5. The top ten percent achievers (in mathematics) had significantly higher self concepts than the bottom ten percent achievers (p. 3863-A).

Good, Biddle, and Brophy (1976) reviewed a study by Brookover and others (1973). This study dealt with socio-economic status and racial composition of schools. The study indicated that schools can and sometimes do differ significantly from one another in achievement even when school populations are similar (Good, Biddle, and Brophy, 1976). In research that compared teachers, rather than schools, it was concluded that effective teaching was demonstrated consistently by certain individuals as measured by their student's test scores (Good, Biddle, and Brophy, 1976). Thus, there appears to exist school variables and teacher variables which do have a significant influence on the learning of students.

Beavers (1981) presented the following information, labeled Table 1, in order to report major studies that relate selected variables to student achievement. The variables that were considered are teacher absenteeism, teacher experience, teacher education level, socio-economic status of student, IQ test scores, cost per student, and resource density. The purpose of the study that Beavers conducted was to determine the relationship between student achievement as measured by mathematics and reading scores on the Iowa Tests of Basic Skills and the above mentioned

TABLE 1

Major Studies Relating Teacher Quality to Student Achievement

Investigator	Grades	Sample	Control Variables	Significant Correlates With Student Achievement
Mollenkopf and Melville (1956)	9, 12	US Schools	SES	Teacher experience and education nonsignificant
Goodman (1959)	7, 11	New York State Individuals	SES	Teacher experience
Thomas (1962)	10, 12	US Schools	SES	Teacher salary
Coleman, et al. (1966)	6, 9, 12	US Individuals	Background	Teacher verbal ability
Burkhead, Fox and Holland (1967)	12	Chicago and Atlanta schools	Median Income, lower grade achievement	Teacher salary, experience
Hanushek (1968)	6	Northern Urban individuals	SES, background	Teacher experience
Raymond (1968)	College freshmen	Virginia districts	SES	Teacher salary, class size
Ribich (1968)	High School	US Individuals	SES	Expenditure per student per student
Kiesling (1969)	6	New York State Districts	SES, prior achievement	Expenditures per student per student
Bowles (1969)	12	US Negro Individuals	Background	Teacher verbal ability, education, class size
Averch and Kiesling (1970)	9	US Schools and Individuals	SES	Teacher salary, class size
Kiesling (1970)	8	New York State Districts	SES	Teacher experience, education--mixed
Michaelson (1970)	6	Eastern City Individuals	SES	Teacher experience
Levin (1970)	6	Eastern City Individuals	SES, student attitudes	Teacher experience
Hanushek (1970)	3	California Individuals	SES, prior achievement	Teacher experience and education nonsignificant
Guthrie, Kleindorfer, Levin (1971)	6	Michigan Individuals	SES	Teacher experience, attitudes
Katzman (1971)	6	Boston Districts	SES	Teacher experience, education
Armor (1972)	6	US Schools	SES, background	Teacher salary, verbal ability
Smith (1972)	6, 9, 12	U.S. Northern Individuals	SES, background	Teacher experience nonsignificant

selected variables. There were six statistically significant relationships that Beavers concluded:

1. There is a statistically significant relationship: teacher experience and student achievement in mathematics.

2. There is a statistically significant relationship: teacher absenteeism and student achievement in mathematics and reading.

3. There is a statistically significant relationship: cost per student and student achievement in mathematics and reading.

4. There is a statistically significant relationship: socio-economic status of pupils and their achievement in mathematics and reading.

5. There is a statistically significant relationship: resource density and student achievement in mathematics and reading.

6. There is a statistically significant relationship: between IQ scores of students and their achievement in mathematics and reading (p. 2460-A).

Summers and Wolfe (1979) concluded that when achievement is measured in the areas of English and mathematics, the more experience the teacher has the greater the achievement growth. The relationship had a greater level of significance when teachers had ten or more years of experience.

Data from the Outlier Study in New York State was analyzed and the study (Bureau of School Programs Evaluation, 1976) concluded that:

> Teachers in the positively deviate schools as a group epitomize what conventional wisdom claims to be characteristics of good teaching staffs. They are better trained and more experienced. They are paid higher salaries and are more likely to be on

> tenure. This still does not inform us as to what well-trained, experienced, and highly paid teachers do to bring about unexpectedly high pupil achievement (p. 28).

In Chicago, Bargen and Walberg (1974) examined the relationship: teacher quality and class size to achievement. Bargen and Walberg reported:

> As expected, earlier-grade achievement accounted for a sizable, highly significant fraction of the variation in achievement outcomes. The additional variation predictable from teacher quality was sizable and highly significant at all grade levels (p. 246).

Murphy, et al. (1982) reported that academic expectations are influenced by classroom practices. He noted five influential classroom practices:

1. Establishing an academically demanding climate.
2. Conducting an orderly, well-managed classroom.
3. Ensuring student academic success.
4. Implementing instructional practices that promote student achievement.
5. Providing opportunities for student responsibility and leadership (p. 24).

Seifert and Beck (1983) believe that time is the common denominator for these five effective practices. The Beginning Teacher Evaluation Study (1980), which was funded by the National Institute of Education, identified conditions and skills a teacher needs to teach effectively. Fisher et al. (1980) reports that the researchers in this study developed a measure of student learning called Academic Learning Time (ALT). Two other time measures were used: engaged time and allocated time. The researchers reported fourteen major findings with respect to the importance of the time variable on student learning or achievement. They are as listed:

1. The amount of time that teachers allocate to instruction in a particular content area is positively associated with student learning in that content area.

2. The proportion of allocated time that students are engaged is positively associated with learning.

3. The proportion of time that reading and mathematics tasks are performed with high success is positively associated with student learning.

4. The proportion of time that reading or mathematics tasks are performed with low success is negatively associated with student learning.

5. Increases in ALT are not associated with more negative attitudes towards mathematics, reading or school.

6. The teacher's accuracy in diagnosing student skill levels is related to student achievement and ALT.

7. The teacher's prescription of appropriate tasks is related to student achievement and student success rate.

8. More substantive interaction of the student and an instructor is associated with higher levels of student engagement.

9. Academic feedback is positively associated with student learning.

10. Structuring the lesson and giving directions on task procedures were positively associated with high student success.

11. Explanation specifically in response to student need is negatively associated with high student success.

12. More frequent reprimands for inappropriate behavior are negatively associated with student learning.

13. The teacher's value system is related to ALT and to student achievement. Teacher emphasis on academic goals is positively associated with student learning.

14. A learning environment characterized by student responsibility for academic work and by cooperation on academic tasks is associated with higher achievement (Fisher, et al., 1980).

In his study, Clauset (1982) reported that the level of achievement of students is influenced by engaged time. He felt that allocated time, however, may not be under the control of teachers. Perhaps Salmon (1982) summed it up best when referring to the time factor. He believes that the best ways to evaluate the effects of the time variable may be in dispute among researchers, but there exists little disagreement as to the fact that the time variable is a very important variable.

The intent of the first section has been to review the literature with respect to student achievement. As can be seen from the review, many factors that influence achievement are non-school factors. The school does not control all the variables that influence student learning. However, as the research cited indicates, there are selected variables that do have an affect on school achievement. Perhaps more research will bring more enlightenment. Featherstone (1974) addresses the issue by stating:

> All the school research so far leaves unexplained a great deal of the variation in students' test scores. You may call whatever explains the leftover variation "social character, 'as yet unmeasured characteristics of students, teachers, and schools,'" . . . . Whatever you call it, it is a mystery to the researchers. (p. 449).

Literature Relating to Prediction of Achievement in Algebra

Focus now on the achievement of first year algebra students. As indicated above, research reports that many factors influence the level of achievement of students. As Hanna, Sonnenschein and Lenke (1983) report, past student grades have long been used in combination with special purpose aptitude tests to predict success/failure in various future courses. Mogull and Rosengarten, Jr. (1974) concur that "in counselling eighth grade students who are about to enter high school, guidance counselors and teachers might find useful a valid method of predicting student success in elementary algebra" (p. 34). They continue by stating that:

> Students themselves would be interested in their chances of success in an algebra course. By helping the student to select the mathematics course most appropriate in relation to his abilities, the counselor will help to reduce student frustration arising from unrealistic goals (p. 34).

Begel (1976) was interested in predicting student achievement. He reviewed eighteen studies and classified prediction into six sets. He reports:

> The first contains measures of general ability, such as IQ. The second consists of measures of previous achievement as determined by standardized tests. The third consists of measures of previous achievement as indicated by teacher assigned grades. The fourth consists of tests of reading ability and achievement. The fifth consists of prognostic tests, while the last consists of attitude measures (p. 6).

Begel's 1976 review examined predictors of success in algebra. He determined that prognostic tests, reading ability and achievement, and student's attitude were poor predictors. He reported that measures of general ability, such as IQ, should not be used alone as predictors of algebra achievement. Begel identified teacher assigned grades and standardized mathematics test scores to be the best predictors of success.

Barnes and Asher (1962) found that the single best predictor of success in first year algebra was the eighth grade mathematics mark with a multiple R of .59. Eleven variables were used in the study. They were: seventh and eighth grade mathematics grades, reading grades for those years, IQ as measured by the <u>Otis Beta Test</u>, the <u>Orleans Algebra Prognosis Test</u> and achievement scores for both arithmetic and reading sections of the <u>Iowa Test of Basic Skills</u> for the seventh and eighth grades. Using just two variables--eighth grade mark and seventh grade ITBS arithmetic achievement score--gave a multiple R of .62. The maximum R was .66 when all eleven variables were used which demonstrates the limited value of the additional variables in predicting success in algebra.

Ivanoff, DeWane, and Praem (1965) examined the differences between ninth grade students who successfully completed general mathematics and first year algebra and those students who were unsuccessful. The six predictor variables used in their study were language test score, reading test score, arithmetic test score, and composite test score from the High School Placement Test published by Science Research Associates, IQ rating, and eighth grade mathematics grade. This study concluded that the High School Placement Test composite score was the single best predictor. The poorest predictors were the IQ rating and the language test score. Using only the other four predictors, the multiple correlation was approximately .735 at the .01 level.

Bell examined five variables in his prediction study. The independent variables were: eighth grade mathematics grade, numerical ability (Differential Aptitude Test), eighth grade science grades, reading score (Sequential Tests of Educational Progress), eighth grade history grade. Bell found that the single best predictor was the eighth grade mathematics grade. He found the correlation to be .592.

In a 1971 dissertation by Goldberg, six prediction variables were examined: sex, race, scores on the Metropolitan Achievement Test, discipline problems, eighth grade reading grades, eighth grade mathematics grades. Goldberg found that students who completed algebra in two semesters had scored higher on the Metropolitan Achievement Test and had higher eighth grade mathematics grades than those students who completed algebra in three semesters.

Lovell's dissertation study in 1969 involved a large number of predictor variables. The two best indicators of success were the California Arithmetic Test and an algebra pretest. It should be noted that Lovett's study did not include the eighth grade mathematics grade as one of its prediction variables.

Callicutt conducted a study in 1961. He included the arithmetic computation and arithmetic reasoning section from the Stanford Achievement Test, eighth grade overall grade point average, eighth grade arithmetic and IQ score as measured by the Longe Thorndike IQ Test. The best basis for prognosis was the eighth grade mathematics grade. The scores that were obtained from the averages made on the arithmetic section of the Stanford Achievement Test also correlated relatively high (.56) with first year algebra achievement.

Mogull and Rosengarten, Jr. (1974) intended to develop a device for predicting student success in first year algebra. They examined the following independent variables: final eighth grade mathematics average, Iowa Algebra Aptitude Test score, and three subtests of the Differential

Aptitude Tests--verbal reasoning, numerical ability, and abstract reasoning. The dependent variable was final examination scores in ninth grade elementary algebra. In the analysis of the data, the highest correlation was the ninth grade algebra examination score and the eighth grade mathematics average. The correlation was .70 for both girls and boys. Mogull and Rosengarten, Jr. state that:

> The results of this study demonstrated that in aptitude testing, high schools could effectively use the results of students' eighth grade mathematics averages for predicting success in ninth grade elementary algebra (p. 38).

They proceed to state that other important factors should be considered such as emotional problems, motivation, maturity, study habits, educational and vocational goals, physical disabilities (hearing, sight) and conflicting interests and activities.

The School Mathematics Study Group beginning in 1962 conducted a five-year longitudinal study of the mathematics achievement of students. Over 100,000 students throughout the country were involved.

> All of the information gathered about these students while they were in grades seven and eight was analyzed to determine which bits of this information best predicted success in algebra (Begel, 1976, p. 18).

The findings indicated that previous achievement in mathematics provided the best indicators of success in algebra.

Hanna, Bligh, Lenke and Orleans (1969) wanted to compare the validities of a special purpose prognosis test, IQ's, teacher predicted algebra grades, and mathematics grades in predicting algebra success and to estimate the extent to which the validities of the individual predictors could be raised by using multiple-regression procedures.

The criterion variable was measured in three ways: (1) mid-year algebra grade; (2) year-end algebra score on the Lankton First-Year Algebra Test, Revised Edition; and (3) year-end algebra grade. The results showed that the total Orleans-Hanna Prognosis Test and its work-sample section predicted all criteria more accurately than did the Otis-Lennon DIQ's, eighth grade teacher's predicted algebra grade, or previous eighth grade mathematics grade. The total Orleans-Hanna test score correlated higher with both mid-year algebra grade and year-end algebra grade. However, the work-sample section of the Orleans-Hanna was more valid in predicting the achievement test score on the Lankton First-Year Algebra Test, Revised Edition.

Three sets of stepwise regression analyses were conducted in the study. The first involved three variables: (1) Orleans-Hanna Algebra Prognosis Test; (2) Deviation IQ's as measured by the Otis-Lennon Mental Ability Test; and (3) eighth grade mathematics teacher's predicted mid-year algebra grade for each student. The results indicated that IQ scores and teacher predicted grades added little to the algebra prognosis test's validity in predicting any of the three criteria.

The second regression analysis used the same three variables as above, only instead of the total algebra prognosis test score, it used only the score from the 58-item work-sample part. This analysis also added a fourth variable which was the eighth grade mathematics grade. The results showed the work sample score of the algebra prognosis test predicted all criteria more accurately than the IQ's, eighth grade mathematics grade, or teacher prediction. Teacher predicted algebra grade did add significantly to the prediction when the criteria used were mid-year algebra grade and year end algebra grade. The eighth grade mathematics grade and IQ scores added little to the prediction of any criterion.

The third regression analysis used only three variables which were: (1) teacher predicted algebra grade; (2) IQ score; and (3) eighth grade mathematics grade. The IQ scores were the greatest contributors for predicting end-of the-year algebra grade and end-of-the-year algebra test score. The teacher predicted algebra grade contributed to all three criteria significantly. Whereas, the eighth grade mathematics score added no significant gain to prediction. Table 2 is provided to present the three sets of multiple-regression analyses.

The multiple correlations in this study reveal that

TABLE 2

Stepwise Regression Analyses (N = 310)

Mid-Year Grade Predictors in Order of Entry	R Each Step	Year-End Grade Predictors in Order of Entry	R Each Step	Year-End Alebra Test Predictors in Order of Entry	R Each Step
Alg. Prog. Test*	.681	Alg. Prog. Test*	.662	Alg. Prog. Test*	.781
Teacher Pred.*	.706	Teacher Pred.*	.679	DIQ*	.792
DIQ	.708	DIQ	.682	Teacher Pred.	.792
Work-Sample Item*	.630	Work-Sample Test*	.617	Work-Sample Test*	.799
Teacher Pred.*	.694	Teacher Pred.*	.667	DIQ*	.804
DIQ	.698	DIQ*	.673	Teacher Pred.*	.806
Math Grade	.699	Math Grade	.673	Math Grade	.806
Teacher Pred.*	.566	DIQ*	.553	DIQ*	.703
DIQ*	.670	Teacher Pred.*	.646	Teacher Pred.*	.728
Math Grade	.674	Math Grade	.648	Math Grade	.731

*Beta weight significant ($p < .05$).

when the algebra prognosis test is used, teacher predicted algebra grade and IQ scores account for only small validity increments in prediction. This is contrary to the studies of other investigators (Dinkel, 1959; Duncan, 1960; Barnes and Asher, 1962; Sabers and Feldt, 1968) that have shown that by using a combination of predictor variables the predictive validity is significantly increased over using a prognosis test alone.

Hanna, Bligh, Lenke and Orleans offer the following as a possible explanation as to why:

> Comparison of the top two sections of Table 2 suggests that the inclusion of student-reported past grades and student-predicted algebra grades in the Algebra Prognosis Test may account for the small validity increments realized when teacher predictions and DIQ's were used with the prognosis test scores. Teacher predictions and DIQ's increased the zero-order validities of the total prognosis test much less in the first set of analyses than they improved the zero-order validities of the work-sample test items in the second set of analyses. These findings lend support to the conclusion that the use of teacher predictions and mental ability test scores may be less productive in predicting grades with (prognosis) tests that incorporate student-reported past grades into their total scores than with more conventional special-purpose prognosis tests (p. 906).

In obtaining a score for this prognosis test, students were asked to report four course grades from their previous year's work. The use of these student-reported grades versus actual past grades was an area of concern. Would this convenience cost one predictive validity? Bligh, Lenke, and Hanna studied this further in 1970. Their study concluded that:

> The student-reported grades were only slightly less valid than actul past grades when used separately. But when used in combination with the work-sample objective items of a prognosis test, the two kinds of grades enjoyed virtually equal predictive validity (p. 244).

Hanna, Sonnenschein and Lenke set out in 1983 with another investigation. There were two purposes of this investigation:

> 1. To verify the validities of the presently used predictor variables of the new edition of the Orleans Hanna Algebra Prognosis Test (1982a).
>
>   a. Student-reported past grades from four school subjects.
>
>   b. Student-predicted algebra grade.
>
>   c. Objective work-sample test with 60 items.
>
> 2. To confirm the suitability of the tentative weights of the four student-reported past grades, the self-predicted algebra grades, and the scores of the 60-item work-sample test as predictors of success in first-year algebra (p. 244-245).

The measure provided by the work-sample test items was the most valid single predictor just as Hanna, Lenke and Bligh reported in their 1969 study. However, the predictive validity of the total score on the Orleans-Hanna test was .601 in comparison to a score of only .492 when only the 60-item work-sample test was used. Thus, as was true from the 1969 study, "grade variables were highly useful in augmenting the validity of the work-sample test items in predicting algebra grades" (p. 246). So, in conclusion, the use of the questionnaire items consisting of student-predicted algebra grades and student-reported past grades in mathematics, science, English and social studies contributes to the predictive efficiency of the Orleans-Hanna Algebra Prognosis Test in forecasting algebra grades.

The second conclusion that the study reached was that a very modest increase in predictive validity of the Orleans-Hanna test would result if the convenient equal weighing of the five grade variables for a maximum of eight points each were changed. However, this was decided against because the gain was very moderate and "did not seem worth the sacrifice in practicality. A practical predictive instrument should be easily administered, conveniently scored by hand or machine, and easily interpreted" (p. 248).

Summary

The literature reveals that many variables influence the achievement of students. Carrier (1981) indicated that many variables were actually non-school factors. However, Edmond (1982) indicates that a characteristic of effective schools is the use of pupil achievement measures as a basis for program evaluation. Thus, to evaluate a school program effectively the achievement of its pupils must be measured. If high achievement implies a good program, educators must concern themselves with which variables influence achievement. Beavers (1981) provided a table that summarized some of the research in this area and that identified some variables that influence achievement. Bligh, Lenke and Hanna (1969) examined the predictive validity of numerous variables in relationship to forecasting algebra achievement. Begel (1976) reviewed eighteen studies and classified prediction of student achievement into six sets.

Callicutt (1961) states that the course selection during the freshman year of high school determines a student's course of action for his/her entire high school career. In particular, Begel (1976) indicates that much research has been done to improve the process of course selection and to improve the process of predicting achievement in algebra specifically. Much of the review of the literature presented here supports the conclusion that eighth grade mathematics grade is the best single indicator of future success in first year algebra. However, as reported in this chapter, Bligh, Lenke and Hanna (1969) found this not to be the single best indicator. Barnes and Asher (1962) also stress the importance of a prediction equation that is of practical use to a school system. And Featherstone (1974) assured the reader that much of the student's test scores variation is a mystery to researchers. Bloom (1980) states that, "By itself this ignorance constitutes a good argument for further research, research in a variety of modes" (p. 450).

Thus, with this review of the literature in mind, the researcher realized that for a school to be effective, the measure of its students' achievement should be one factor used to evaluate its school program. Specifically, the researcher decided to focus on a first year algebra program. In the school where the research study was conducted, the 1982-83 percentage of unsuccessful (below a C average) first year algebra students was reported to be 47 percent. The researcher conducted a study that employed eight predictor variables to determine whether successful or unsuccessful achievement could have been forecasted for first year algebra students. The researcher also used first nine weeks algebra grades to see if they could have predicted end of the year algebra achievement. Thus, the researcher heeded Bloom's advice (1980) and conducted further school research.

Chapter III

METHODOLOGY

Introduction

This chapter explains the methods and procedures that this study followed. The purpose of the study was twofold. The first purpose was to examine eight independent variables to see if any one or any combination of them could assist in identifying students who would be successful or unsuccessful in achieving the objectives of a first year algebra course. If so, the researcher believed that this would enable counselors and teachers to assist students in making proper mathematics course selections. The second purpose of the study was to determine if first nine weeks algebra grades could predict successful or unsuccessful achievement for the year in the first year algebra course. The researcher believed that if the first nine weeks algebra grade could predict end-of-the-year achievement, then this information could be used at the end of the first grading period to reschedule unsuccessful students into other courses where they might be more successful and experience some academic learning. A basic assumption that this study makes is that educators have a responsibility to advise students as to their capabilities and to direct students into courses that are intellectually and physically challenging and within their ability to experience some success. The ultimate decision of course selection, however, should rest with the student and legal guardian of that student.

Chapter Three focuses on a description of the setting and subjects, the design and data collection, and the analytical methods employed.

The Setting

The school district in which the study took place is a part of a metropolitan area. In the past eleven years, residential growth has converted the district from a rural to a suburban area. In 1982-83, this public school system was one of the largest units in the nation, with an enrollment over 122,000. Administratively, the school in which the study was conducted is divided into six subschools, one subschool for each grade (7-12). Each subschool contains a principal, guidance counselor and secretary for the pupils assigned to it.

The community is composed of students from diverse ethnic and cultural backgrounds. The school services a military installation and because of this has an unusual number of transients. In 1983, it was estimated that almost one out of every four households moves each year. Demographic change also results from in-migration.

In this school community, the majority of parents work for private firms, the federal government, or are in the armed services. The State Department of Education Survey of High School Seniors, 1980, revealed that for this school around 40 percent of the fathers were engaged in managerial or professional occupations, 32 percent in the military, 24 percent in skilled or semi-skilled occupations, and 4 percent in unskilled occupations. As for the mothers of these students, 75 percent were employed outside the home with one-fourth of the mothers in professional occupations and one-half in clerical related occupations.

The Student Body

Table 3 presents figures on student enrollment. This Table displays the data as indicated by the end of the year pupil accounting report.

Scholastic Aptitude and Achievement

The school underwent a Self-Study in 1983. The report on scholastic aptitude and achievement indicated that the school wanted to determine whether students were learning at a level expected of him/her. The report went on to state that, "percentile, stanines, grade equivalents, and growth scale values provided for each of the subject matter areas and the deciles reported for specific skill and content objectives permit logical conclusions." The Science Research Associates (SRA) Test measures achievement. The

TABLE 3

Student Body Enrollment

	Enrollment by Years*					
Grades	1978	1979	1980	1981	1982	1983
7	484	509	499	535	524	567
8	535	484	495	443	503	514
9	649	558	509	500	462	526
10	556	573	491	446	435	423
11	515	484	500	451	408	404
12	481	456	455	453	400	371
Totals	3468	3220	2949	2828	2732	2805

school reported that the SRA composite scores paralleled the composite scores of the Short Test of Educational Ability (STEA). The report stated:

> Test score results are utilized to aid in identification of academically unsuccessful students (AUS) and gifted and talented students in order for them to be scheduled in the proper level of discipline. The results also are used to guide the student into a college, vocation, skill development, and to plan for the future.
>
> Three hundred sixty-nine (369) graduates of the class of 1982 filled in educational and occupational intentions that revealed:
>
> 1) 52 percent planned to attend four-year colleges or universities.
>
> 2) 14 percent planned to attend two-year colleges.
>
> 3) 6 percent planned to attend vocational or technical schools.
>
> 4) 28 percent planned for full-time employment or military service.

<u>Instructional Content</u>

The 1983 Self-Study Report states the following:

> This Secondary School is a comprehensive school which recognizes that individuals differ in physical, academic and emotional development. The development of the Educational Program must enhance individual potential and promote a positive feeling of self. The philosophy of developing educational programs for these Secondary students has reflected the belief that the school exists for the benefit of the students and community. As a part of a changing society, this Secondary School must periodically review its programs to meet the academic, vocational and aesthetic needs of its students.

This school system has developed a Program of Studies. This is a guideline as to the objectives that are to be taught in each course. Each teacher receives a Program of Studies for his/her discipline.

The mathematics department of this school offers basically three sequences. A student is allowed to change sequences as long as the student's prerequisites are appropriate. Table 4 shows the sequence of mathematics courses. The following is a description of the first year algebra course that was involved in this study.

> <u>ALGEBRA I</u> - Grades 9-12, full year, 1 credit.
>
> This is the first course in college preparatory mathematics. Course content includes exponents, linear equations and inequalities, graphs in a coordinate plane, systems of equations, polynomials, rational expressions, radicals and irrational numbers and quadratic equations. (General Mathematics I or Algebra I, Part I, or Pre-Algebra prerequisites.)

In Appendix A, one can find the detailed instructional objectives of the first year algebra course as defined by the school system's Program of Studies.

<u>The Subjects</u>

For Research Questions 1 and 2.

The subjects of this study were all students with eighth grade SRA scores who were enrolled in first year algebra within the first ten days of the 1984-85 school year and completed the first semester. All subjects were

TABLE 4

Sequence of Mathematics Courses

8	9	10	11	12
General Math I (Grade 8)	Algebra I, Part I General Math II	Algebra I, Part II Math Applications Algebra I, Part I	Math Applications Algebra I, Part II Algebra I Geometry	Geometry Algebra II
Pre-Algebra General Math Grade 8)	Algebra I	Geometry	Algebra II Algebra II-Trigonometry	Trigonometry Math Analysis Analytic-Geometry Functions
Algebra I	Geometry	Algebra II Algebra II-Trigonometry	Trigonometry Math Analysis Analytic Geometry-Function	Calculus AB Calculus BC

Two Computer Science courses are also available for students to schedule.

enrolled in grades nine through twelve. There were 308 students who were enrolled in first year algebra as of September 1984. There were ten sections of algebra with five different teachers. At the end of the first semester, one algebra teacher was replaced by a new teacher. All the teachers were certified by the state to teach mathematics.

For Research Question 3.

The subjects were all students who completed first year algebra during the 1983-84 school year. There were 233 subjects, and they were in grades nine through twelve.

Data Collection

Permission was obtained from the school system and the building principal to collect the data that was needed for the study. Assurances were given for the protection of the anonymity of subjects. When the data collection was complete, all subjects' names were removed from the data collection forms.

The study involved 3 research questions:

1. Is there a relationship among the eight predictor variables and teacher assigned semester grade, Mid-Year Algebra test score, and department final algebra exam score?

2. Can successful or unsuccessful algebra achievement be predicted by the eight predictor variables when achievement is measured by:

a. Teacher assigned semester grade?

b. Mid-Year Algebra Test score?

c. Department Final Algebra Exam score?

3. Can first nine weeks grades be used to predict successful or unsuccessful algebra achievement as indicated by the final year grade in algebra?

To address questions 1 and 2, the researcher collected data that related to eight variables that were used as the predictor variables and three variables to be used as criteria variables for achievement, the dependent variable.

The eight variables that were selected as predictor variables (independent variables) of successful or unsuccessful achievement in first year algebra were:

1. Science Research Associates composite score (eighth grade).

2. Science Research Associates comprehension score (eighth grade).

3. Science Research Associates math computation score (eighth grade).

4. Science Research Associates math concepts score (eighth grade).

5. Orleans-Hanna Prognosis Test score.

6. Previous mathematics course.

7. Previous final mathematics grade.

8. Study habits score.

The criterion variable (dependent variable) was achievement. Achievement was measured three ways:

1. Mid-Year Algebra Test score (Standardized Test).

2. Semester Average (arithmetic average of the teacher assigned first and second marking period grades).

3. Final Examination score (first year algebra examination that was devised by algebra teachers and was used by the Mathematics Department as the end of the year examination for all first year algebra students).

In order to address research question three, the teacher assigned first nine weeks algebra grades and the teacher assigned final year algebra grades were obtained from the reported teacher grade sheets.

Predictor Variables

A. Science Research Associates (SRA) Test Battery.

Four of the predictor variables used were scores earned on the SRA battery of achievement tests that is administered to eighth grade students in this school system. The SRA survey tests are designed to measure a student's level of achievement in a particular subject area. Measures of reliability for the SRA Achievement Series were developed using the KR-20 formula. KR-20 reliabilities range from .89 to .96 for all tests in the series. The four specific subtest scores that were used are: math concepts, math computation, reading comprehension, and composite score that is based on reading, language and math scores. These scores were obtained from the Director of Guidance's master list or from the individual student's personal folder which was located in his/her guidance counselor's office.

B. Previous Mathematics Course.

The information for this predictor variable was obtained from the student's personal folder. The transcript provided the researcher with this data. Previous courses were as follows: pre-algebra, general mathematics I (8th grade) or math 8, algebra, geometry, general mathematics II (9th grade), general mathematics III (10th grade), algebra I, part I. Below the reader finds the way in which the school defines these course offerings and descriptions of each.

GENERAL MATHEMATICS I - Grade 8, full year.

Included in this course is a study of concepts of numeration; fundamental operations on whole numbers, fractions, integers, and percent; use of equations and inequalities; use of graphs, statistics and probability; intuitive concepts of geometry; and use of measurement skills. 7th grade minimum competencies, which are part of the state graduation requirement, are emphasized including operations on whole numbers and decimals, percent, making change, perimeter and area of rectangular figures, averages, units of measure, parallelism and parts of a circle. 8th grade minimum competencies, which are part of the state graduation requirement, are emphasized. These include determination of wages, consumer banking, cost of purchase, interpretation of statistical graphs, utility bills, gasoline mileage and interpretation of tax tables. Diagnostic test and teacher recommendation also allow for the appropriate placement of various mathematical abilities.

PRE-ALGEBRA - Grades 7-8, full year.

Pre-algebra includes a study of numeration for rational and irrational numbers; operations on integers and rational numbers; use of equations, inequalities and graphs; concepts of geometry; use of equations, inequalities and graphs; concepts of geometry; use of measurement; and consumer applications. 8th grade minimum competencies, which are part of the state graduation requirement, are emphasized. These include determination of wages, consumer banking, cost of purchase, interpretation of statistical graphs, utility bills, gasoline mileage and interpretation of tax tables. Diagnostic tests and teacher recommendation also allow for the appropriate placement of various mathematical abilities.

GENERAL MATHEMATICS II - Grades 9-12, full year, 1 credit.

Emphasis is on minimum competencies for high school graduation. Topics include arithmetic operations, plane and solid geometric figures, simple equations and inequalities, measurement and consumer application. (General Mathematics I prerequisite.)

GENERAL MATHEMATICS III - Grades 10-12, full year, 1 credit.

Students are offered an additional year to become proficient in basic math skills. The course includes a review of general mathematics and the solving of problems related to the consumer topics of personal money management, business procedure, transportation, budgeting, taxation, banking and insurance. (General Mathematics II prerequisite.)

ALGEBRA I - Grades 9-12, full year, 1 credit.

This is the first course in college preparatory mathematics. Course content includes exponents, linear equations and inequalities, graphs in a coordinate plane, systems of equations, polynomials, rational expressions, radicals and irrational numbers and quadratic equations.

(General Mathematics I or Algebra I, Part I, or Pre-algebra prerequisites.)

ALGEBRA I, PART I - Grades 9-12, full year, 1 credit

This course is designed to enable students to take a full year to complete the first half of Algebra I; hence the course progresses at a slower pace than Algebra I. Students review basic computation skills and course content includes exponents, open expressions, equations and one variable, inequalities, graphs in a coordinate plane, and systems of two linear equations. Algebra I, Part I counts as one of the credits needed to graduate, but will not be counted by colleges as an algebra credit. (General Mathematics I prerequisite.)

GEOMETRY - Grades 9-12, full year, 1 credit.

Students are offered the opportunity to draw logical conclusions, write mathematical proofs and apply techniques of algebra to geometric problems. Course content includes points, lines and planes; angles and triangles; perpendicular lines; parallel lines; areas, proportionality and similarity; coordinate geometry; circles; and solid figures. (Algebra I prerequisite.)

Let it be noted that not all students involved in this study were in this school system last year. However, it is assumed that the course descriptions used by this school system are similar to those used by other school systems.

C. Final Grade in the Previous Mathematics Course

The final grade was that grade assigned by the teacher as an end-of-the-year mark in the particular mathematics course taken. The mark was scaled from 4.0 to 0.0 (A to F). This final grade was recorded from the student's transcript.

D. Study Habits

Data for the predictor variable that was labeled "Study Habits" was obtained by asking each first year algebra student four questions. A four-item questionnaire was given to each student by his/her teacher. The questionnaire itself can be found in Appendix B. It was scored by the researcher and the possible range of the scores was from 4-0 points. The score was determined as follows: for question #1, one point was given for response (a) Yes; for question #2, one point was given for response (a) Yes; for question #3, one point was given for response (d) or (e) 1 hour or more; for question #4, one point was given for response (d) over 75 percent of the days. The questionnaire was administered at the end of the third nine weeks.

E. Orleans-Hanna Algebra Prognosis Test

The Orleans-Hanna Algebra Prognosis Test was an instrument that was used by the researcher. The purpose of this prognosis test is to forecast semester or year achievement in first year algebra. It has two parts. The first part is a five-item questionnaire where the students record their most recent report card grade in English, social studies, science and mathematics. The students must also record the grade that they think they would receive if they took algebra. This questionnaire section is graded as follows: A = 4, B = 3, C = 2, D = 1, F = 0. The reported grades are assigned the aforementioned numerical values and then added together and multiplied by two.

The second part of this prognosis test contains nine lessons in algebra, each followed by a test on the lesson. A review test follows lesson nine. The students are allowed 40 minutes to study the lessons and to answer the test questions. In all, there are 58 items that comprise part two of this test. The scores from both parts are added together to yield the final score for the prognosis test.

Predictive validity for the prognosis test is reported to be .74. According to Orleans-Hanna, coefficients for predictive validity tend to fall between .40 to .60, with a median value of .50 (Orleans-Hanna Algebra Prognosis Test: Manual, 1969, 16).

The reliability of the test tells the researcher the extent to which the test yields consistent measures. The test-retest method was employed to measure the reliability of this prognosis test. Reliability of the total test was .95. Reliability of the questionnaire was .95. Reliability of the 58-item work section was .94.

This prognosis test was administered to the first year algebra students by their teachers within the first ten days of the 1984-1985 school year. The researcher collected the answer sheets and tabulated a score for each student.

F. First Nine Week Algebra Grades.

The first nine weeks' grades were obtained from the teacher grade sheets. The researcher used these grades to answer the third research question: Do first nine weeks' algebra grades predict successful or unsuccessful algebra achievement for the year?

Criterion Variables

Achievement, the dependent variable, was measured in three ways for the first two research questions. They are: Teacher Assigned Semester grade, Mid-Year Algebra Test score, and Department Algebra Final Exam score. Achievement, for the third research question was measured by the Final Year Algebra grade as assigned and reported by the teacher.

A. Teacher Assigned Semester Grade.

The first and second nine weeks' grades were obtained from the teacher grade sheets. Since teachers only give seniors a semester grade, the researcher assigned the following values to the reported letter grades of underclassmen:

A	=	4.0
B+	=	3.5
B	=	3.0
C+	=	2.5
C	=	2.0
D+	=	1.5
D	=	1.0
F	=	0.0

The first and second nine weeks' grades were then arithmetically averaged into what is defined in this study as the teacher assigned semester average. A student with a semester average of 2.0 or higher was defined to be a successful achiever. A semester average less than 2.0 was defined to be an unsuccessful achiever.

B. Mid-Year Algebra Test

The Mid-Year Algebra Test, Form A, Harcourt, Brace & World, Inc., New York, 1968, was used to measure first semester algebra achievement. It was administered by the algebra teachers the last week of the second nine weeks to all present first year algebra students. Students who were absent for the first administration of the test were scheduled for a make-up day the following week.

The Mid-Year Algebra Test purports to measure the objectives of the first semester of algebra instruction. It was administered in a 50-minute class period. It consisted of 43 multiple choice algebra test items. The split-half reliability coefficient was reported to be .85 with a standard error of measurement of 2.9. The researcher determined that the Mid-Year Algebra Test had a high degree of content validity. A score of 15 or better was considered to be a successful achiever of first semester algebra. A score below 15 was considered to be an unsuccessful achiever of first semester algebra.

C. Departmental Algebra Examination Score.

A final year algebra examination had originally been developed by algebra teachers at another school in the same school system. These algebra teachers had constructed the examination so as to test the first year algebra objectives as outlined in the school system's Program of Studies. The examination and the algebra objectives from the Program of Studies can be found in Appendices C and A, respectively. The department chairman of the school in which the study was conducted requested a copy of the examination and permission to use the exam during the 1983-84 school year. The examination was administered in this school for the first time in June of 1984. The Office of Research and Evaluation was asked to do an item analysis of the examination with respect to level of difficulty and ability to discriminate. The Office of Research and Evaluation did so and sent a representative to the school in April of 1985 to discuss its findings. The item analysis information for the 100-item exam is presented in Appendix D. The last week of school, first year algebra students took the department algebra final examination. The score they obtained on this 100-item examination was the third measure of achievement that the researcher used in this study. A score of 64 or more was defined to be a successful achiever in first year algebra. A score below 64 was defined to be an unsuccessful first year algebra student.

D. Final Algebra Grade (Teacher Assigned)

The final algebra grades for 233 students (9th-12th) for the 1983-84 school year were recorded by the researcher. The teacher grade sheets were used as the source of information. Any student whose grade was a C or better was recorded as a successful achiever in first year algebra. Any student who received below a C was recorded as an unsuccessful achiever in first year algebra.

Procedure for Data Analysis

The first research question this study asked was:

> Question 1: Is there a relationship among the eight predictor variables and teacher assigned semester algebra grades, Mid-Year Algebra Test, and Departmental Final Algebra Examination score?

Therefore, correlation analysis provided the means for testing whether any significant relationships existed. Pearson product-moment correlation coefficients were calculated between the three criteria for success and each of the predictors and also among the predictors. Listed below are the hypotheses that were tested at the .05 level of significance.

Criterion (Teacher Assigned Semester Grade) and Predictor Variables

Hypothesis 1. The SRA score in reading comprehension does not significantly correlate with the teacher assigned semester grade.

Hypothesis 2. The SRA score in math computation does not significantly correlate with the teacher assigned semester grade.

Hypothesis 3. The SRA score in math concepts does not significantly correlate with the teacher assigned semester grade.

Hypothesis 4. The SRA composite score does not significantly correlate with the teacher assigned semester grade.

Hypothesis 5. The Orleans-Hanna Algebra Prognosis Test score does not significantly correlate with the teacher assigned semester grade.

Hypothesis 6. The previous math course does not significantly correlate with the teacher assigned semester grade.

Hypothesis 7. The previous final math grade does not significantly correlate with the teacher assigned semester grade.

Hypothesis 8. The study habits' score does not significantly correlate with the teacher assigned semester grade.

Criterion (Mid-Year Algebra Test Score) and Predictor Variables

Hypothesis 9. The SRA score in reading comprehension does not significantly correlate with the Mid-Year Algebra

Test score.

Hypothesis 10. The SRA score in math computation does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 11. The SRA score in math concepts does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 12. The SRA composite score does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 13. The Orleans-Hanna Algebra Prognosis Test score does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 14. The previous math course does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 15. The previous final math grade does not significantly correlate with the Mid-Year Algebra Test score.

Hypothesis 16. The study habits' score does not significantly correlate with the Mid-Year Algebra Test score.

Criterion (Department Final Algebra Examination score) and Predictor Variables

Hypothesis 17. The SRA score in reading comprehension does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 19. The SRA score in math concepts does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 20. The SRA composite score does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 21. The Orleans-Hanna Algebra Prognosis Test score does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 22. The previous math course does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 23. The previous final math grade does not significantly correlate with the Department Final Algebra Examination score.

Hypothesis 24. The study habits' score does not significantly correlate with the Department Final Algebra Examination score.

Among Predictors

Hypothesis 25. The eight predictor variables do not significantly correlate with each other.

Among Criteria

Hypothesis 26. The three criteria variables do not significantly correlate with each other.

Thus, the researcher used correlation, specifically Pearson product-moment correlation, to describe the relationship between any combination of two variables from the total eleven variables that were used in the study (8 predictor variables and 3 criteria variables). Beavers (1981) states that:

> Correlational studies include research which attempts to discover relationships through the use of correlation coefficients. The purpose of the correlation coefficient is to express in mathematical terms the degree of relationship between any two variables (p.51).

Borg and Gall (1971, 318) continue:

> If the relationship is perfectly positive (for each increment in one variable there is a corresponding increment in the other), the correlation coefficient will be 1.00. If the relationship is perfectly negative, it will be -1.00. If there is no relationship, the coefficient will be zero. If two variables are somewhat related, the coefficients will have a value between zero and 1.00 (if the relationship is positive) or between zero and -1.00 (if negative). Thus, the correlation coefficient is a precise way of stating the extent to which one variable is related to the other (p. 318).

<u>Discriminant Function Analysis</u>

This study was interested not only in correlations between the various combinations of variables. The second and third research questions of the study involved prediction. The two questions were:

<u>Question 2</u>. Can successful or unsuccessful algebra

achievement be predicted by the eight predictor variables when achievement is measured by:

a. Teacher Assigned Semester Grade?

b. Mid-Year Algebra Test Score?

c. Department Final Algebra Exam Score?

Question 3. Can successful or unsuccessful algebra achievement be predicted by first nine weeks algebra grade when achievement is measured by teacher assigned algebra grade?

This study used the statistical procedure that is called discriminant function analysis. This is a technique that is used in prediction studies when the criterion (dependent) variable is nominal. The nominal criterion variable, achievement, in this study was dichotomous. There were only two categories that students could fall in: successful achievement or unsuccessful achievement.

Huck (1974) explains:

> When a researcher conducts a prediction study with nominal criterion variable, the statistical techniques known as discriminant function analysis must be used instead of the multiple correlation technique used with continuous criterion variables. There are two main types of discriminant function analysis. One is appropriate for nominal criterion variables with two categories and the other for variables with three or more categories (p. 161).

Analysis of the data was made by computer. The computer program that was used was the Statistical Package for the Social Sciences (SPSS). The discriminant function analysis was conducted. The computer provided the following output:

1. A discriminant function prediction equation.
2. A cut-off score.
3. An F ratio (significant or non-significant).

Discriminant Function Prediction Equation

For each criterion variable a discriminant function prediction equation was calculated. All predictor variables were used. Identifying the predictor variables and criterion variables as indicated by Table 5, the researcher determined three discriminant function predictor equations concerning the second research question. The three equations are reported in Chapter 4, but all are in the form:

$$D = .031\ VAR1 + .004VAR2 + \ldots\ldots + .021VAR8$$

D is the symbol used for the predicted score. D is the criterion variable that indicated whether the student would be successful or unsuccessful in first year algebra. The predictor variables were VAR1, VAR2, ... VAR8. The coefficients of the VAR's were chosen "so as to maximize correct classification when the researcher is predicting to a nominal criterion variable" (Huck, 1974, 162).

To answer the third research question a fourth equation was determined in the form: $D = .362VAR9$, where VAR9 is the first nine weeks grade in first year algebra and D is the

TABLE 5

Notation and Description of Variables Used
for Discriminant Function Analysis
(Research Question 2)

NOTATION	DESCRIPTION
Predictor Variables	
VAR1	Algebra Aptitude (as measured by Orleans-Hanna score).
VAR2	Study Habits Score
VAR3	SRA Reading Comprehension (Eighth Grade)
VAR4	SRA Math Concepts (Eighth Grade)
VAR5	SRA Math Computation (Eighth Grade)
VAR6	SRA Composite Score (Eighth Grade)
VAR7	Previous Math Course
VAR8	Previous Math Grade
Criterion Variables	Successful or Unsuccessful Achievement as Measured by:
ACH1	Teacher Assigned Semester Average
ACH2	Mid-Year Algebra Test Score
ACH3	Final Examination Score

predicted score. Again D is the criterion variable, achievement (see Table 6). Successful versus unsuccessful achievement was defined to mean a teacher assigned final algebra grade of C or better versus less than a C.

Critical or Cut-off Score

The numerical value of D that the discriminant function prediction equation yielded was compared to a previously chosen number. This number is called a critical or cut-off score. The purpose of this critical or cut-off score was to determine the classification of D scores. If a D score for a potential algebra student was above the critical or cut-off score, the he/she was predicted to be a member of the group of successful first year algebra students. If the D score of the student was below the critical cut-off score, then the student was predicted to be a member of the group of unsuccessful first year algebra students.

F Test of the Discriminant Function

The nominal criterion variable used in this study was achievement. It was a dichotomous criterion variable. Students in this study were predicted to be successful or unsuccessful first year algebra students. However, to predict which of two groups a student would fall into could be done by chance alone and yield 50 percent accuracy. The F test is a test of significance. It is used to determine whether the discriminant function prediction equation does a

TABLE 6

Notation and Description of Variables Used for Discriminant Function analysis (Research Question 3)

NOTATION	DESCRIPTION
Predictor Variable	
VAR9	First Nine Weeks' Algebra Grade
Criterion Variable	Successful or Unsuccessful Achievement as Measured by:
ACH4	Final Year Algebra Grade

better job at accurate prediction than chance does by itself. In Chapter Four, the F test results are reported for each discriminant function prediction equation. This reported F ratio relates the degree to which the technique of discriminant function analysis accurately makes predictions.

Cross Validation

The discriminant function prediction equations were determined by data obtained from an existing population of students. However, the reason for deriving these discriminant function prediction equations was to predict the successful or unsuccessful achievement of other potential first year algebra students. No two groups of people are identical. In order to have confidence that these equations would accurately predict successful or unsuccessful achievement in a different group of first year algebra students, a technique called cross validation was employed. The purpose of the cross-validation technique was to determine whether the prediction equations would be successful when used with a new group of students.

Huck (1974, 159) states:

> The technique of cross validation involves four simple steps.
>
> 1) The original group of people (for whom both predictor and criterion scores are available) is randomly divided into two subgroups.

2) Just one of the subgroups is used to develop the prediction equation.

3) This equation is used to predict a criterion score for each person in the second subgroup (i.e., the subgroup that was not used to develop the prediction equation).

4) The predicted criterion scores for people in the second subgroup are correlated with their actual criterion scores. A high correlation (that is, significantly different from zero) means that the prediction equation works for people other than those who were used to develop the equation.

The researcher used this cross-validation technique to check the usefulness of the derived discriminant function prediction equations. The results are reported in Chapter Four.

Summary

Chapter One provided an explanation and overview of this research study. The background of the problem and the theoretical framework of the study were presented. Chapter I states the research problem, the study's purpose, the research questions and the design. Basic assumptions and limitations of the study are noted.

Chapter Two presented a review of the literature. It discussed student achievement, prediction and prediction of first year algebra achievement.

Chapter Three explained the methodology of the research. The setting, student body, scholastic, aptitude and achievement, and instructional content of the involved subjects were all thoroughly described. Data collection methods and procedures for data analysis were presented. Correlation analysis was discussed and Pearson product-moment correlation coefficients were used in the study. Discriminant function analysis was explained with respect to its purpose, the discriminant function prediction equation, the critical or cut-off score, and the F ratio as a measure of significance. Cross validation was used as the technique that measured whether the discriminant function prediction equations could be used accurately with other groups of potential algebra students.

Chapter Four will now report the findings of this study. A computer, using the Statistical Package For the Social Sciences, analyzed all data and performed all computations.

Chapter Five will discuss conclusions. The final part presents some recommendations that the researcher would make to potential future investigators in the same area of study.

CHAPTER IV

RESULTS AND ANALYSES

This chapter presents the results and findings of the study in terms of the variables that correlate with successful or unsuccessful achievement in first year algebra. The chapter is organized so as to address each research question in turn. The research question is stated at the beginning of each section and the results and analyses are correlated.

Research Question 1: Correlation Analysis

The first research question addressed in this study asks if there is a relationship among the eight predictor variables, Teacher Assigned Semester Algebra Grade, Mid-Year Algebra Test score, and Department Final Algebra Examination score. Pearson product-moment correlation coefficients were calculated to address this question.

Predictors vs. Achievement Correlation

The results of the correlation of the eight predictor variables with each of the three measures of achievement are found in Table 7. As indicated in Chapter Three, the first eight hypotheses state that there is no significant relationship between achievement as measured by Teacher

TABLE 7

Pearson Correlation Coefficients of Predictor Variables With Achievement Variables

Predictor Variable	Criterion Variable		
	ACH1	ACH2	ACH3
Algebra Prognosis	.66*	.57*	.56*
Study Habits	.17*	.09	.25*
SRA Reading	.15*	.27*	.04
SRA Math Concepts	.46*	.51*	.45*
SRA Math Computation	.50*	.45*	.38*
SRA Composite	.37*	.47*	.30*
Previous Math Course	-.13*	-.06	-.04
Previous Math Grade	.26*	.18*	.17*

*Significant at the .05 level.

Assigned Semester Grade (ACH1) and the eight predictor variables. Thus all eight hypotheses are rejected. All eight of the predictors correlated significantly with Teacher Assigned Semester Average. The Algebra Prognosis Test (.66) was the strongest relationship. The coefficient of determination was .44. This means that 44 percent of the variance in the Algebra Prognosis Test is associated with the variance in achievement. The SRA Math Computation (.50), SRA Math concepts (.46), and SRA Composite (.37) followed next in order of strength of correlation.

As stated in Chapter Three, the next eight hypotheses (Hypotheses 9 through 16) state that there is no significant relationship between achievement as measured by Mid-Year Algebra Test score (ACH2) and the eight predictor variables. Six of the predictors did correlate significantly. Only the Study Habits (.09) variable and Previous Course (-.06) variable were not significant. Thus all hypotheses are rejected except for two (Hypotheses 14 and 16). The strongest correlation is again the Algebra Prognosis Test (.57). SRA Math Concepts (.51), SRA Composite (.47) and SRA Math Computation (.45) were the next three predictors in terms of correlation strength.

The next eight hypotheses (Hypotheses 17 through 24) state that there is no significant relationship between achievement as measured by Department Final Algebra Examination score (ACH3) and the eight predictor variables.

Again six of the predictors correlated significantly. The Previous Course (-.04) and the SRA Reading score (.04) were the two non-significant correlations. The Algebra Prognosis Test (.56) had the strongest relationship. SRA Math Concepts (.45), SRA Math Computation (.38), and SRA Math Composite (.30) followed in strength.

Regardless of which of the three measures of achievement was used, the strongest relationship always existed between achievement and the Algebra Prognosis Test. Also, in terms of strength of correlation, the next three largest coefficients were SRA Math Concepts, SRA Math Computation, and SRA Math Composite in some order. Thus the strongest four significant correlations were between the four predictor variables mentioned above and achievement as measured by Teacher Assigned Semester Average (ACH1), Mid-Year Algebra Test score (ACH2), and Department Final Algebra Exam score (ACH3).

Predictors vs. Predictors Correlation

The results of the correlation of the eight predictor variables with each other are presented in Table 8. Hypothesis 25 stated that the eight predictor variables do not significantly correlate with each other. The correlation coefficients were all significant except for the Study Habits variable which was only significant with the Algebra Prognosis Test (.12) and the Previous Course (-.13) and these correlations were very weak.

TABLE 8

Pearson Correlation Coefficients of Predictor

Variables With Predictor Variables

Predictors	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6	VAR7	VAR8
Algebra Prognosis	1.00	.12*	.34*	.57*	.48*	.52*	-.22*	.48*
Study Habits		1.00	-.11	.02	.07	-.01	-.13*	.06
SRA Reading			1.00	.38*	.37*	.77*	-.34*	.12*
SRA Math Concepts				1.00	.57*	.69*	-.32*	.25*
SRA Math Computation					1.00	.65*	-.35*	.36*
SRA Composite						1.00	-.43*	.26*
Previous Course							1.00	.19*
Previous Course Grade								1.00

*Significant at the .05 level.

As expected, the highest correlation between the predictors existed between SRA Composite and SRA Reading (.77), SRA Composite and SRA Math Concepts (.69). The SRA Composite score is derived from the SRA Math, SRA Reading, and SRA Language scores. Thus the SRA Composite score is actually a function of the scores on the other SRA tests mentioned above and thus unsurprisingly showed a strong correlation.

Achievement vs. Achievement Correlation

Achievement of algebra students was measured in three different ways. These measures of achievement were correlated to observe the relationships. As was expected the variables for achievement were strongly correlated. As Table 9 indicates, the Teacher Assigned Semester Grade had the largest coefficient (.71) when paired with the Department Final Algebra Exam score. The Mid-Year Algebra Test showed a strong correlation with the Teacher Assigned Semester Grade (.65) and with the Department Final Algebra Examination score (.62). This strong relationship between these variables is to be expected if, in fact, each of these three variables is measuring algebra achievement.

Research Question 2: Discriminant Analysis

The second research question that this study addressed is if successful or unsuccessful algebra achievement can be predicted by eight predictor variables (stated in Chapter

TABLE 9

Pearson Correlation Coefficients of Achievement Variables With Achievement Variables

Achievement Variables	ACH1	ACH2	ACH3
Teacher Assigned Semester Average	1.00	.65*	.71*
Mid-Year Algebra Test Score		1.00	.62*
Department Final Examination Score			1.00

*Significant at the .05 level.

Three) when achievement is measured by Teacher Assigned Semester Average, Mid-Year Algebra Test score, Department Final Algebra Examination score. In order to answer this question, discriminant function analysis was the procedure employed.

Teacher Assigned Semester Average

There were 228 cases processed. The computer randomly selected 98 to use in the discriminant function analysis. These 98 cases were assigned to one of two groups, an unsuccessful group or a successful group. The cut-off score was 2.0. The successful group had a semester average of 2.0 or greater. The unsuccessful group had a semester average less than a 2.0. Of the 98 total cases used, 40 were designated to the unsuccessful group and 58 to the successful group. The group means and group standard deviations for each variable are reported in Table 10.

The discriminant function analysis that was conducted used a stepwise procedure to select the single best discriminating variable and then continued to select variables that were best able to improve the value of the discrimination criterion in combination with the previously chosen variable(s). The results of the stepwise procedure are summarized in Table 11. Only five of the original eight predictor variables were selected before the F level or tolerance became insufficient for further computation. The five selected variables (Algebra Prognosis Test score, SRA

TABLE 10

Group Means and Standard Deviations for

Predictor Variables

(Criterion: Teacher Assigned Semester Grade)

Predictors		Group 1 Unsuccessful	Group 2 Successful	Total
VAR1	$\bar{x}$	62.4	74.9	69.7
	s	9.2	7.9	10.4
VAR2	$\bar{x}$	1.0	1.3	1.2
	s	.9	.8	.8
VAR3	$\bar{x}$	394.6	404.2	400.3
	s	49.1	36.0	41.9
VAR4	$\bar{x}$	412.5	452.3	436.0
	s	55.9	38.2	50.0
VAR5	$\bar{x}$	462.0	499.7	484.3
	s	40.9	43.7	46.3
VAR6	$\bar{x}$	495.8	533.1	517.8
	s	61.7	42.7	54.2
VAR7	$\bar{x}$	2.8	1.8	2.2
	s	2.3	1.4	1.9
VAR8	$\bar{x}$	2.3	3.0	2.7
	s	.8	1.1	1.0

$\bar{x}$ = the group mean.

s = the group standard deviation.

TABLE 11

Summary Table of Discriminant Analysis

(Criterion: Teacher Assigned Semester Average)

Step	Action Entered	Action Removed	VARS IN	Wilks' Lambda	Sig	Label
1	VAR1		1	.6594	.0000	Algebra Prognosis
2	VAR7		2	.6222	.0000	Previous Course
3	VAR3		3	.5997	.0000	SRA Reading
4	VAR5		4	.5714	.0000	SRA Math Computation
5	VAR8		5	.5551	.0000	Previous Course Grade

Variables not used in the final canonical discriminant function equation:

VAR2 Study Habits

VAR4 SRA Math Concepts

VAR6 SRA Composite

Reading score, SRA Math Computation score, Previous Course, and Previous Course Grade) produced a considerable degree of separation as indicated by the final Wilks' Lambda (.5551) and its associated chi-squared (55.02) test of significance (df = 5, signif. = .000). The canonical correlation coefficient for the discriminant function was .66. The discriminant function analysis equation had an F ratio of 14.74 with 5 and 92 degrees of freedom. The coefficient of determination of .44 indicates that the equation accounts for 44 percent of the variance in first semester algebra achievement.

Standardized and unstandardized canonical discriminant function coefficients are presented in Table 12. The standardized coefficient of the Algebra Prognosis variable (1.0345) indicates that it is more than twice as important as the other four selected variables. The other four variables (Previous Course, SRA Reading score, SRA Math Computation score and Previous Course Grade) contribute relatively the same amount to the function, -.4743, .4316, -.411, -.3130 respectively. As was reported in the Pearson product-moment correlation analysis, it is interesting to note that the correlation coefficient for the Algebra Prognosis Test and Teacher Assigned Semester Average was .66, producing a coefficient of determination of .44. This indicates that 44 percent of the total variance in algebra achievement as measured by Teacher Assigned Semester

TABLE 12

Canonical Discriminant Function

(Criterion: Teacher Assigned Semester Average)

Predictor Variable	Standardized Coefficients	Unstandardized Coefficients
Algebra Prognosis	1.0345	.1211
Previous Course	- .4743	- .0001
SRA Reading	.4316	.0001
SRA Math Computation	- .4111	- .2206
Previous Course Grade	- .3130	- .3048
(Constant)	.0000	-7.4754

Eigen value	.8013		
Canonical Correlation	.6669		
Wilks' Lambda	.5551		
Chi-squared	55.02	df = 5	sig = .0000
F level	14.74	df = 5 and 92	sig = .0000

Average can be associated with the variance in the Algebra Prognosis Test score.

The unstandardized coefficients yielded the following discriminant function analysis equation.

D= -7.4754+.1211VAR1-.0001VAR7+.0001VAR3-.2206VAR5-.3048VAR8

The value of this equation lies in the fact that when the unstandardized coefficients are multiplied by the raw values of the discriminating variables, a discriminant score is arrived at which classifies a case as a successful or unsuccessful first semester algebra student as measured by Teacher Assigned Semester Grade.

The discriminant function analysis equation classified the cases selected for use in the analysis (the screening sample). There was a total of 117 cases. Of these, 52 cases were in the actual unsuccessful group of which 42 (80.8 percent) were correctly predicted to be unsuccessful by the derived discriminant function equation. Moreover, 10 (19.2 percent) were incorrectly predicted to be successful. The actual successful group was comprised of 65 cases of which 51 (78.5 percent) were correctly predicted to be successful and 14 (21.5 percent) were incorrectly predicted to be unsuccessful. The percent of grouped cases that were correctly classified was 79.4 percent.

For the purpose of cross validation the discriminant function analysis equation was applied to the same five predictor variables of a second sample of subjects (the calibration sample) to predict into which group, successful or unsuccessful, each case would be placed. The calibration sample consisted of 111 total cases. Of these, 49 cases were in the actual unsuccessful group. The discriminant function equation correctly predicted 36 (73.5 percent) to be unsuccessful. It incorrectly predicted 13 (26.5 percent) to be successful. There were 62 cases in the actual successful group of which there were 45 (72.6 percent) predicted to be successful and 17 (27.4 percent) to be unsuccessful. The percent of grouped cases correctly classified was 72.9 percent. Chance would yield a 50 percent correct classification. Thus the discriminant function equation is improving on chance by 22.9 percent to 29.4 percent. The summarized classification results are found in Table 13. Also the cross-validation procedure indicates that this equation may be used successfully with other groups of algebra students.

A summary of the entire results based on the criterion, Teacher Assigned Semester Average, can be found in Table 14. The summary is divided into three sections: Pearson Correlations, Discriminant Analysis Summary and Classification Results.

Mid-Year Algebra Test Score

There were 228 cases processed. The computer randomly selected 98 cases for use in the discriminant function

TABLE 13

Classification Results

(Criterion: Teacher Assigned Semester Average)

Screening Group

Classification Results For Cases Selected for Use In The Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	52	42 80.8%	10 19.2%
Successful	65	14 21.5%	51 78.5%

Percent of grouped cases correctly classified 79.4%.

Calibration Group

Classification Results For Cases Not Selected For Use In the Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	49	36 73.5%	13 26.5%
Successful	62	17 27.4%	45 72.6%

Percent of grouped cases correctly classified 72.9%.

TABLE 14

Summary Table

Criterion: Teacher Assigned Semester Average

Pearson Correlations Significant With Criterion

Algebra Prognosis	.66
SRA Math Computation	.50
SRA Math Concepts	.46
SRA Math Composite	.37
Previous Math Grade	.26
Study Habits	.17
SRA Reading	.15
Previous Math Course	-.13

Discriminant Analysis Summary

Variables Selected	Step Entered	Wilk's Lambda	Coefficients Std.	Coefficients Unstd.	Unsuccessful Gp. $\bar{X}$	Unsuccessful Gp. (s)	Successful Gp. $\bar{X}$	Successful Gp. (s)
Algebra Prognosis	1	.6594	1.0345	.1211	62.4	(9.2)	74.7	(7.9)
Previous Course	2	.6222	-.4743	-.0001	2.8	(2.3)	1.8	(1.4)
SRA Reading	3	.5997	.4316	.0001	394.6	(49.1)	404.2	(36.0)
SRA Math Computa.	4	.5714	-.4111	.2206	462.0	(40.9)	499.7	(43.7)
Prev. Math Grade	5	.5551	-.3130	-.3048	2.3	(.8)	3.0	(1.1)
				-7.4754(c)				

Canonical Correlation	.6669	
Wilks' Lambda	.5551	
Chi-squared	55.02	df = 5
F-Level	14.74	df = 5 and 92

Variables Not Selected

SRA Math Concepts
SRA Composite
Study Habits

Classification Results

Group	Percent of Grouped Cases Correctly Classified
Screening	79.4%
Calibration	72.9%

analysis. These 98 cases were assigned to one of two groups for analysis. The cut-off score was 15. A case was assigned to the successful algebra achievement group if the score was 15 or more and to the unsuccessful algebra achievement group if the score was less than 15. Of the total 98 cases, 82 were assigned to the successful group and 16 to the unsuccessful group. The group means and group standard deviations for each of the eight predictor variables are reported in Table 15.

The discriminant function analysis, using the stepwise procedure, selected the SRA Math Concepts score as the greatest discriminating variable in the first step with a Wilks' Lambda of .7973. Step 2 included the Algebra Prognosis score in the analysis. This lowered Wilks' Lambda to .7705. Step 3 entered the Study Habits variable and this reduced Wilks' Lambda to .7550 with its associated chi-square test of significance of 26.55 with 3 degrees of freedom and significance .0000. The F level or tolerance was insufficient for further computation. Thus the SRA Math Concepts score, Algebra Prognosis Test score, and Study Habits were the three variables selected as the best discriminators. The SRA Reading score, SRA Math Computation score, SRA Composite score, Previous Course, and Previous Course Grade were the five predictors that were not used in the discriminant function analysis equation. A summary table is provided with this information. See Table 16. The

TABLE 15

Group Means and Standard Deviations for

Predictor Variables

(Criterion: Mid-Year Algebra Test Score)

Predictors		Group 1 Unsuccessful	Group 2 Successful	Total
VAR1	$\bar{x}$	60.9	71.4	69.7
	s	7.6	10.1	10.4
VAR2	$\bar{x}$	1.0	1.2	1.2
	s	1.0	.8	.8
VAR3	$\bar{x}$	383.1	403.6	400.3
	s	39.1	41.8	41.9
VAR4	$\bar{x}$	385.3	445.9	436.0
	s	55.4	42.6	50.0
VAR5	$\bar{x}$	448.8	491.3	484.3
	s	39.1	44.6	46.3
VAR6	$\bar{x}$	473.8	526.4	517.8
	s	54.4	50.2	54.2
VAR7	$\bar{x}$	3.1	2.0	2.2
	s	2.6	1.7	1.9
VAR8	$\bar{x}$	2.4	2.8	2.7
	s	.8	1.1	1.0

$\bar{x}$ = the group mean.

s = the group standard deviation.

TABLE 16

Summary Table of Discriminant Analysis

(Criterion: Mid-Year Algebra Test Score)

Step	Action Entered	Action Removed	VARS IN	Wilks' Lambda	Sig	Label
1	VAR4		1	.7973	.0000	SRA Math Concepts
2	VAR1		2	.7705	.0000	Algebra Prognosis
3	VAR2		3	.7550	.0000	Study Habits

Variables not used in the final canonical discriminant function equation:

VAR3 SRA Reading

VAR5 SRA Math Computation

VAR6 SRA Composite Score

VAR7 Previous Course

VAR8 Previous Course Grade

canonical correlation coefficient was .49. The coefficient of determination was .24 and indicates that the discriminant function analysis equation accounts for 24 percent of the variance in algebra achievement as measured by the Mid-Year Algebra Test.

Standardized and unstandardized canonical discriminant function coefficients are provided in Table 17. The standardized coefficient of the SRA Math Concepts score variable is .7616. This indicates that it contributes twice as much as the Algebra Prognosis score variable (.3847) and more than twice as much as the Study Habits variable (.2896) to the discriminant function analysis equation.

The unstandardized coefficients yielded the following discriminant function analysis equation.

$$D = -10.5421 + .3263VAR2 + .0003VAR1 + .0001VAR4$$

The value of this equation is that raw scores can be substituted directly in the equation in order to classify a case as successful or unsuccessful. The derived equation was used to classify the cases selected for use in the analysis (the screening sample). There were 117 total cases involved. Twenty-two cases were actually unsuccessful. Of these, 16 (72.7 percent) were correctly predicted to be unsuccessful. Six (27.3 percent) were incorrectly predicted to be successful. of the 95 cases that were actually successful, 76 (80.0 percent) were correctly predicted to be

TABLE 17

Canonical Discriminant Function

(Criterion: Mid-Year Algebra Test Score)

Predictor Variable	Standardized Coefficients		Unstandardized Coefficients
Algebra Prognosis	.3847		.0003
Study Habits	.2896		.3263
SRA Math Concepts	.7616		.0001
Constant	.0000		-10.5421
Eigen Value	.3244		
Canonical Correlation	.4949		
Wilks' Lambda	.7550		
Chi-Squared	26.55	df = 3	sig = .0000
F level	10.16	df = 3 and 94	sig = .0000

successful but 19 (20.0 percent) were predicted to be unsuccessful. The overall result is that 78.6 percent of the grouped cases were correctly classified.

In order to cross validate the findings of this discriminant function analysis equation, a calibration group was selected. The same three predictor variables were used in the equation to predict the classification of 111 total cases. Only 14 cases were actually unsuccessful. Of these, 9 (64.3 percent) were correctly predicted to be unsuccessful and 5 (35.7 percent) were incorrectly predicted to be successful. There were 97 cases that were actually successful and 63 (64.9) percent) were correctly predicted to be successful and 34 (35.1 percent) were incorrectly predicted to be unsuccessful. This indicates that the discriminant function analysis equation correctly classified 64.8 percent of the grouped cases for the calibration group. This is 14.8 percent better than chance. The classification results are found in Table 18 for both the screening sample and the calibration sample.

In order to organize the results based on the criterion Mid-Year Algebra Test, a summary table is provided. Table 19 reports the findings of the Pearson Correlations, Discriminant Analysis and Classification Results.

Department Final Algebra Examination Score

There were 228 cases provided. Of these, 98 cases were selected by the computer randomly for use in developing the

TABLE 18

Classification Results

(Criterion: Mid-Year Algebra Test Score)

Screening Group

Classification Results For Cases Selected for Use In The Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	22	16 72.7%	6 27.3%
Successful	95	19 20.0%	76 80.0%

Percent of grouped cases correctly classified 78.6%.

Calibration Group

Classification Results For Cases Not Selected For Use In the Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	14	9 64.3%	5 35.7%
Successful	97	34 35.1%	63 64.9%

Percent of grouped cases correctly classified 64.8%.

TABLE 19

Summary Table
Criterion: Mid-Year Algebra Test

PEARSON CORRELATIONS

Significant:

Algebra Prognosis	.57	SRA Math Computation	.45
SRA Math Concepts	.51	SRA Reading	.27
SRA Composite	.47	Previous Math Grade	.18

Not Significant:

Study Habits	.09	Previous Math Course	-.06

DISCRIMINANT ANALYSIS SUMMARY

Variables Selected	Step Entered	Wilks' Lambda	Coefficients Std.	Coefficients Unstd.	Unsuccessful Group $\bar{X}$	Unsuccessful Group (S)	Successful Group $\bar{X}$	Successful Group (S)
SRA Math Concepts	1	.7973	.7616	.0001	385.3	(55.4)	445.9	(42.6)
Algebra Prognosis	2	.7705	.3847	.0003	60.9	(7.6)	71.4	(10.1)
Study Habits	3	.7550	.2896	.3263	1.0	(1.0)	1.2	(.8)
				-10.542 (c)				

Canonical Correlation	.4949	
Wilks' Lambda	.7550	
Chi-Squared	26.55	df = 3
F-Level	10.16	df = 3 and 94

Variables Not Selected

SRA Math Computation	Previous Course
SRA Composite	Previous Course Grade
SRA Reading	

CLASSIFICATION RESULTS

Group	Percent of grouped cases correctly classified
Screening	78.6%
Calibration	64.8%

discriminant function analysis equation. The 98 cases were assigned to one of two groups for the analysis. The cut-off score was 64. A case was assigned to the successful algebra achievement group if the score was 64 or more and to the unsuccessful algebra achievement group if the score was less than 64. Of the total 98 cases, 50 were labeled unsuccessful and 48 were labeled successful. The group means and group standard deviations for each of the eight predictor variables are reported in Table 20.

The stepwise procedure followed in the discriminant analysis selected the Algebra Prognosis Test score as the most discriminating of the eight predictor variables in step 1. Wilks' Lambda was .7012 and F = 40.90 with 1 and 96 degrees of freedom. The SRA Math Computation score was selected in step 2 (Wilks' Lambda = .6547) followed by the Study Habits variable (Wilks' Lambda = .6274) and Previous Course Grade (Wilks' Lambda = .5997). The four variables that were not selected are SRA Reading score, SRA Math Concepts score, SRA Composite score and Previous Course. A summary is found in Table 21.

At the conclusion of the stepwise procedure the F level was 15.51 with 4 and 93 degrees of freedom. Wilks' Lambda was .5997 with chi-squared = 48.05 and 4 degrees of freedom, significance .0000. The canonical correlation coefficient was .63 which determines the coefficient of determination to be .40. This indicates that the discriminant function

TABLE 20

Group Means and Standard Deviations for

Predictor Variables

(Criterion: Department Final Examination Score)

Predictors		Group 1 Unsuccessful	Group 2 Successful	Total
VAR1	$\bar{x}$	64.1	75.5	69.7
	s	9.6	7.8	10.4
VAR2	$\bar{x}$	1.0	1.3	1.2
	s	.9	.8	.8
VAR3	$\bar{x}$	391.5	409.4	400.3
	s	41.7	40.5	41.9
VAR4	$\bar{x}$	416.1	456.9	436.0
	s	46.9	44.7	50.0
VAR5	$\bar{x}$	465.4	504.0	484.3
	s	42.4	42.2	46.3
VAR6	$\bar{x}$	498.8	537.7	517.8
	s	50.4	51.3	54.2
VAR7	$\bar{x}$	2.4	2.0	2.2
	s	2.0	1.8	1.9
VAR8	$\bar{x}$	2.5	2.9	2.7
	s	.9	1.1	1.0

$\bar{x}$ = the group mean.

s = the group standard deviation.

TABLE 21

Summary Table of Discriminant Analysis

(Criterion: Department Final Examination Score)

Step	Action Entered	Action Removed	VARS IN	Wilks' Lambda	Sig	Label
1	VAR1		1	.7012	.0000	Algebra Prognosis
2	VAR5		2	.6247	.0000	SRA Math Computation
3	VAR2		3	.6274	.0000	Study Habits
4	VAR8		4	.5997	.0000	Previous Course Grade

Variables not used in the final canonical discriminant function equation:

VAR3 SRA Reading

VAR4 SRA Math Concepts

VAR6 SRA Composite

VAR7 Previous Course

analysis equation accounts for 40 percent of the variance in algebra achievement as measured by the Department Final Algebra Examination score.

Standardized and unstandardized canonical discriminant function coefficients are provided in Table 22. The standardized coefficient of the Algebra Prognosis score is .9144 and indicates that this variable contributes more discriminating power than the SRA Math Computation (.5052), Previous Course Grade (-.4046), or Study Habits (.3526).

The unstandardized coefficients yield the following discriminant function analysis equation.

$$D= -12.4530 + .1038VAR1 + .4032VAR2 + .0001VAR5 - .3834VAR8$$

Raw scores for the four selected variables can be substituted directly in the equation in order to classify a case as successful or unsuccessful.

This discriminant function analysis equation classified the cases selected for use in the analysis. There were 117 cases. Of this total, 54 cases were actually unsuccessful. Of these, 40 (74.1 percent) were correctly predicted to be unsuccessful and 14 (25.9 percent) were incorrectly predicted to be successful. Of the 63 cases that were actually successful, 44 (69.8 percent) were correctly predicted to be successful and 19 (30.3 percent) were incorrectly predicted to be unsuccessful. The overall

TABLE 22

Canonical Discriminant Function

(Criterion: Department Final Examination)

Predictor Variable	Standardized Coefficients	Unstandardized Coefficients	
Algebra Prognosis	.9144	.1038	
Study Habits	.3526	.4032	
SRA Math Computation	.5052	.0001	
Previous Course Grade	-.4046	-.3834	
(Constant)	.0000	-12.4530	
Eigen value	.6673		
Canonical Correlation	.6326		
Wilks' Lambda	.5997		
Chi-squared	48.05	df = 4	sig = .0000
F level	15.51	df = 4 and 93	sig = .0000

result is that 71.7 percent of the grouped cases were correctly classified.

For cross validation, the derived discriminant function equation was used on a calibration group. The four selected predictor variables were used in the equation to classify members of the group. The calibration group had 111 ccases. There were 50 cases that were actually unsuccessful. Of these, 36 (72.0 percent) were correctly predicted to be unsuccessful and 14 (28.0 percent) were incorrectly predicted to be successful. There were 61 actual cases that were successful. Of these, 41 (67.2 percent) were correctly predicted to be successful, whereas 20 (32.8 percent) were incorrectly predicted to be unsuccessful. The discriminant equation correctly classified 69.3 percent of the group cases correctly. These classification results can be found in Table 23.

Based on the criterion, Department Final Exam, a summary is provided of the Pearson Correlations, Discriminant Analysis and Classification Results. This organization of findings is found in Table 24.

Research Question 3: Discriminant Analysis

Final Algebra Grade

The third research question that this study addressed is if successful or unsuccessful algebra achievement can be predicted by first nine weeks algebra grade when achievement

TABLE 23

Classification Results

(Criterion: Department Final Examination Score)

Screening Group

Classification Results For Cases Selected for Use In The Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	52	40 74.1%	14 25.9%
Successful	63	19 30.2%	44 69.8%

Percent of grouped cases correctly classified 71.7%.

Calibration Group

Classification Results For Cases Not Selected For Use In the Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	50	36 72.0%	14 28.0%
Successful	61	20 32.8%	41 67.2%

Percent of grouped cases correctly classified 69.3%.

TABLE 24

Summary Table
Criterion: Department Final Examination Score

PEARSON CORRELATIONS

Significant:			
Algebra Prognosis	.56	SRA Math Composite	.30
SRA Math Concepts	.45	Study Habits	.25
SRA Math Computation	.38	Previous Math Grade	.17
Not Significant:			
SRA Reading	.04	Previous Math Course	-.04

DISCRIMINANT ANALYSIS SUMMARY

Variables Selected	Step Entered	Wilks' Lambda	Coefficients Std.	Coefficients Unstd.	Unsuccessful Group X	Unsuccessful Group (S)	Successful Group X	Successful Group (S)
Algebra Prognosis	1	.7012	.9144	.1038	64.1	(9.6)	75.5	(7.8)
SRA Math Computation	2	.6574	.5052	.0001	465.4	(42.4)	504.0	(42.2)
Study Habits	3	.6274	.3526	.4032	1.0	(.9)	1.3	(.8)
Previous Course Grade	4	.5997	-.4046	-.3824 -12.4530	2.5	(.9)	2.9	(1.1)

Canonical Correlation	.6326	
Wilks' Lambda	.5997	
Chi-Squared	48.05	df = 4
F-Level	15.51	df = 4 and 93

Variables Not Selected

SRA Reading	SRA Composite
SRA Math Concepts	Previous Course

CLASSIFICATION RESULTS

Group	Percent of grouped cases correctly classified
Screening	71.7%
Calibration	69.3%

is measured by teacher assigned final algebra grade. In order to answer this question, the statistical procedure known as discriminant function analysis was utilized.

There were 233 cases processed. The computer randomly selected 119 cases to be used in the analysis. These 119 cases were assigned to one of two groups, an unsuccessful group or a successful group. The cut-off score was 2.0. The successful group had a 2.0 or greater. The unsuccessful group had less than a 2.0. Of the 119 cases, 57 were assigned to the unsuccessful group and 62 to the successful group. The group means and group standard deviations are found in Table 25.

The predictor variable, first nine weeks grade, yielded an F ratio of 109.6 with 1 and 117 degrees of freedom. Wilks' Lambda was .5162 with chi-squared of 77.02 with 1 degree of freedom and significance .0000. The canonical correlation coefficient was .69 which makes the coefficient of determination .48. This indicates that the discriminant function analysis equation accounts for 48 percent of the variance in algebra achievement as measured by the final year grade.

The standardized canonical discriminant function coefficient is 1.000 since it is the only variable in the equation. The unstandardized canonical discriminant function coefficient is 1.2096 and the constant is -2.6987. This yields the following discriminant function analysis

TABLE 25

Group Means and Standard Deviations for Predictor Variable

(Criterion: Final Algebra Grade)

Predictor		Group 1 Unsuccessful	Group 2 Successful	Total
First Nine Weeks' Grade	$\bar{X}$	1.4	2.9	2.2
	S	.9	.7	1.1

equation.

$$D = -2.6987 + 1.2096VAR9$$

These results are found in Table 26.

This discriminant function analysis equation was used to classify the cases selected for use in the analysis (the screening sample). There were 119 cases. Of these, 57 cases were actually unsuccessful. Of these, 48 (84.2 percent) were correctly predicted and 9 (15.8 percent) were incorrectly predicted. There were 62 actual successful cases of which 51 were correctly predicted to be successful and 11 (17.7 percent) were incorrectly predicted to be unsuccessful. This meant that 83.1 percent of all the grouped cases were correctly classified by the derived equation.

In order to cross validate the findings, a calibration group of 114 cases was used. Of the 44 actual unsuccessful cases, 39 (88.6 percent) were correctly predicted and 5 (11.4 percent) were incorrectly predicted to be unsuccessful. Of the 70 actual successful cases, 58 (82.9 percent) were correctly predicted and 12 (17.1 percent) were incorrectly predicted to be unsuccessful. The overall percent of correctly classified grouped cases was 85.0 percent which was higher than the screening group's 83.1 percent. This equation could be used with future algebra students. Table 27 presents these classification results. Also, Table 28 organizes all the results based on the

TABLE 26

Canonical Discriminant Function

(Criterion: Final Algebra Grade)

Predictor Variable	Standardized Coefficients	Unstandardized Coefficients
First Nine Weeks Algebra Grade	1.0000	1.2096
(Constant)		-2.6987

Eigen value	.9370		
Canonical Correlation	.6955		
Wilks' Lambda	.5162		
Chi-squared	77.02	df = 1	sig = .0000
F level	109.6	df = 1 and 117	sig = .0000

TABLE 27

Classification Results

(Criterion: Final Algebra Grade)

Screening Group

Classification Results For Cases Selected for Use In The Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	57	48 84.2%	9 15.8%
Successful	62	11 17.7%	51 82.3%

Percent of grouped cases correctly classified 83.1%.

Calibration Group

Classification Results For Cases Not Selected For Use In the Analysis

Actual Group	No. of Cases	Predicted Group Unsuccessful	Membership Successful
Unsuccessful	44	39 88.6%	5 11.4%
Successful	70	12 17.1%	58 82.9%

Percent of grouped cases correctly classified 85.0%.

TABLE 28

Summary Table

Criterion: Final Algebra Grade

DISCRIMINANT ANALYSIS SUMMARY

Variables Selected	Step Entered	Wilks' Lambda	Coefficients Std.	Coefficients Unstd.	Unsuccessful Group $\bar{X}$	Unsuccessful Group (S)	Successful Group $\bar{X}$	Successful Group (S)
First Nine Weeks' Grade	1	.5162	1.0000	1.2096 -2.6987 (c)	1.4	(.9)	2.9	(.7)

Canonical Coefficient	.6955	
Wilks' Lambda	.5162	
Chi-Squared	77.02	df = 1
F-Level	109.6	df = 1 and 117

CLASSIFICATION RESULTS

Group	Percent of grouped cases correctly classified
Screening	83.1%
Calibration	85.0%

criterion, final algebra grade.

Overview

The findings reported in this chapter are based on four different criteria used for measuring achievement. In order to organize these findings, a table has been provided. Table 29 presents the overall findings of this study.

TABLE 29

Table of Study Findings

Criterion	Teacher Assigned Semester Average	Mid-Year Algebra Test	Department Final Exam Score	Final Year Grade
PEARSON CORRELATION				
	Algebra Prognosis Test .66 SRA Math Computation .50	Algebra Prognosis Test .57 SRA Math Concepts .51	Algebra Prognosis Test .56 SRA Math Concepts .45	
DISCRIMINANT ANALYSIS				
Variables Selected	Algebra Prognosis Test Previous Course SRA Reading SRA Math Computation Previous Course Grade	SRA Math Concepts Algebra Prognosis Test Study Habits	Algebra Prognosis Test SRA Math Computation Study Habits Previous Course Grade	First Nine Weeks' Grade
Variables Not Selected	SRA Math Concepts SRA Composite Study Habits	SRA Math Computation SRA Composite SRA Reading Previous Course Previous Course Grade	SRA Math Concepts SRA Composite SRA Reading Previous Course	
Canonical Correlation	.6669	.4949	.6326	.6955
F ratio	14.74 df = 5 & 92	10.16 df = 3 & 94	15.51 df = 4 & 93	109.6 df = 1 & 117
Wilks' Lambda	.5551	.7550	.5997	.5162
Chi-Squared	55.02 df = 5	26.55 df = 3	48.05 df = 4	77.02 df = 1
PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED:				
Screening Group	79.4%	78.6%	71.7%	83.1%
Calibration Group	72.9%	64.8%	69.3%	85.0%

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This study was concerned with predictors of successful or unsuccessful achievement of high school students in first year algebra. The study addressed three basic research questions.

Research Question 1

The first research question asked if there exists a relationship among eight predictor variables, Teacher Assigned Semester Algebra Average, Mid-Year Algebra Test Score, and Department Final Algebra Examination Score. The findings indicated that all eight of the predictor variables correlated significantly with each other at the .05 level of significance except for the Study Habits variable. This variable correlated significantly with the Previous Course variable (negative .13) and Algebra Prognosis variable (.12). The study concluded that achievement as measured by the Teacher Assigned Semester Average criterion correlated significantly with all eight predictor variables. When achievement was measured by the Mid-Year Algebra Test Score, six of the eight predictors significantly correlated. The Study Habits and Previous Math Course variables did not.

When the Department Final Examination Score was used as the criterion, six of the eight predictors significantly correlated. SRA Reading and Previous Math Course did not.

The Algebra Prognosis Test Score showed the strongest correlation of all eight predictor variables with each of the three measures of achievement (Teacher Assigned Semester Average .66, Mid-Year Algebra Test Score .57, and Department Final Examination Score .56). This is contrary to one of the findings of Begel in his 1976 review of eighteen studies on predictors of success in algebra. He determined that prognosis tests were poor predictors.

Begel identified teacher assigned grades and standardized mathematics test scores to be the best predictors of success. This study found that the standardized SRA Mathematics Concepts variable and SRA Mathematics Computation variable were correlated significantly with all three measures of achievement within a range of .38 to .51.

Barnes and Asher (1962) found that the single best predictor of success in first year algebra was the eighth grade mathematics mark with a multiple R of .59. This study found the Previous Math Grade variable to correlate with Teacher Assigned Semester Average (.26), Mid-Year Algebra Test (.18), and Department Final Examination (.17). All were statistically significant but weak. None were near the strength reported by Barnes and Asher. Perhaps a possible explanation as to why would include the fact that the variable, Previous Math Grade, in this study was not always the eighth grade mathematics grade. This study included freshmen through seniors. Some students had even skipped mathematics for a year.

Of the eight predictor variables that this study examined, the conclusion is that the strongest correlation with algebra achievement as measured by Teacher Assigned Semester Average, Mid-Year Algebra Test, and Department Final Algebra Examination is the Orleans-Hanna Algebra Prognosis Test. This prognosis test is different from the standard prognosis test types. This is because it consists of two parts. One part is the standard format of a prognosis test. This part contains nine algebra lessons each followed by a test on the lesson. A review test follows lesson nine. There is a total of 58 items in this part of the prognosis test. The other part of this test is perhaps what contributes to making it such a strong predictor variable. This part is a five-item questionnaire. Students record their most recent report card grades in English, social studies, science and mathematics. The students must also record the grade that they think they would receive if they were to take algebra. There is a total of 40 points in this section. The problem-solving portion of the test represents approximately 60% of the total prognosis test's value and the reporting of grades section accounts for 40%. In conclusion, the reporting of past grades in combination with the prognosis items is making the Orleans-Hanna Algebra Prognosis Test the strongest of the eight predictor variables for all three achievement criteria. Begel (1976) identified the importance of teacher assigned grades in predicting success in algebra. Barnes and Asher (1962), as mentioned previously, found that the single best predictor of success in first year algebra was the eighth grade mathematics mark. Bell (1971) also found the single best predictor to be the eighth grade mathematics grade. Mogull and Rosengarten, Jr. (1974) again found the highest correlation to be the eighth grade mathematics average.

Research Question 2

The second research question asked if successful or unsuccessful algebra achievement could be predicted by the eight predictor variables or some combination of them when achievement is measured by Teacher Assigned Semester Average, Mid-Year Algebra Test, and Department Final Algebra Examination. Since achievement is measured in three ways, each criterion is addressed separately.

Teacher Assigned Semester Average

The study concluded that five of the eight predictor variables were significant in predicting successful or unsuccessful algebra achievement as measured by the Teacher

Assigned Semester Average. The five predictor variables are: Algebra Prognosis Test, Previous Course, SRA Reading Score, SRA Math Computation Score, and Previous Course Grade. A discriminant function analysis equation was derived using these five predictors. This equation accounts for 44% of the total variance. The Algebra Prognosis Test is the most discriminating variable and it contributes at least twice as much as any one of the other four selected variables. In the analysis, the discriminant function equation correctly classified 79% of the cases. Through cross validation, it was determined that this discriminant equation using the same five predictors could correctly classify 73% of the grouped cases. This indicated that the equation could be useful in counseling potential first year algebra students.

Mid-Year Test Score

The study concluded that three of the eight predictor variables were of value in determining which students would be successful on the Mid-Year Test and which would not be. The selected variables were the SRA Math Concepts, Algebra Prognosis Test, and Study Habits. The discriminant function analysis equation that was derived accounts for 24% of the total variance. The SRA Math Concepts variable discriminated the most, contributing at least twice as much as either one of the other two. Although the equation correctly classified 79% of the original cases, upon cross validation its accuracy was reduced to 65%. This is still 15% more accurate than by chance alone. However, one is cautioned in its use due to the 14% drop from 79% to 65% upon cross validation.

Department Final Algebra Examination Score

The study concluded that four of the eight predictor variables were of value in discriminating between the successful and unsuccessful achiever on the Department Final Examination. The discriminant analysis selected the Algebra Prognosis Test, SRA Math Computation Score, Study Habits, and Previous Course Grade. The most discriminating of these four predictors was the Algebra Prognosis Test which contributed almost twice as much as any one of the other three selected variables. The discriminant function analysis equation correctly classified 72% of the original cases. By cross validation, it was determined that this discriminant equation correctly classified 69% of the cases in a different group. This indicated that the equation could be used in counseling potential algebra students.

Research Question 3

The third research question asked if successful or unsuccessful algebra achievement could be predicted by the first nine weeks' grade. The study concluded that the first nine weeks' algebra grade can be used to predict successful or unsuccessful algebra achievement. This one variable, first nine weeks' alebra grade, accounts for 49% of the total variance in algebra achievement at the end of the year. The discriminant function analysis equation correctly classified 83% of the original cases used in the analysis. Upon cross validation, the equation correctly classified 85% of the cases in the second group. This clearly indicates that this equation can be used to counsel other algebra students at the conclusion of the first nine weeks' marking period.

Since this discriminant analysis equation involved only one predictor variable, it is possible to determine that a first nine weeks' grade of 2.24 or greater would predict a student to be in the successful group of achievers. However, there was no grade of 2.24 assigned. A grade of C+ equaled 2.5 and a grade of C equaled 2.0. Table 30 is presented to summarize the conclusions of the derived discriminant function analysis equation. A student with a first nine weeks' grade of C+ or above is predicted to fall in the successful group of algebra achievers at the end of the year. The probability of that happening for a first nine weeks' mark of A is .98, B+ is .95, B is .86, C+ is .66. However, if the first nine weeks' grade is a C or below, the student is predicted to fall in the unsuccessful group of algebra achievers at the end of the year. The probability of being in the unsuccessful group if the first

TABLE 30

Prediction and Probability Table

First Nine Weeks' Grade		1st Predicted Group	Probability
A	4.0	Successful	.98
B+	3.5	Successful	.95
B	3.0	Successful	.86
C+	2.5	Successful	.66
C	2.0	Unsuccessful	.61
D+	1.5	Unsuccessful	.83
D	1.0	Unsuccessful	.94
F	0.0	Unsuccessful	.99

First Nine Weeks' Grade		2nd Predicted Group	Probability
A	4.0	Unsuccessful	.01
B+	3.5	Unsuccessful	.04
B	3.0	Unsuccessful	.13
C+	2.5	Unsuccessful	.33
C	2.0	Successful	.38
D+	1.5	Successful	.16
D	1.0	Successful	.05
F	0.0	Successful	.00

nine weeks' grade is a C is .61, D+ is .83, D is .94, and F is .99. The conclusion is that the first nine weeks' grade can predict end-of-the-year algebra achievement.

Summary

In conclusion, the single best predictor of algebra achievement was the Algebra Prognosis Test. This was true when achievement was measured after the first semester by the Teacher Assigned Semester Average or the standardized Mid-Year Algebra Test. It was also true when end-of-the-year algebra achievement was measured by the Mathematics Department's Final Examination.

Using discriminant analysis, the eight predictor variables were utilized to derive an equation that would discriminate between successful and unsuccessful algebra students. Three discriminant equations were calculated. Using Teacher Assigned Semester Average as the criterion, the variables Algebra Prognosis Test, SRA Reading Score, SRA Math Computation Score, Previous Course, and Previous Course Grade were selected. Mid-Year Algebra Test used as the criterion yielded SRA Math Concepts, Algebra Prognosis Test, and Study Habits as the selected variables. Department Final Exam as the criterion selected the variables Algebra Prognosis Test, SRA Math Computation, Study Habits, and Previous Course Grade. Each of the three discriminant equations could be used with other potential algebra students although the cross validation for the Mid-Year Algebra Test criterion was not as accurate as the other two criteria.

Using discriminant analysis, the first nine weeks' algebra grade was used to discriminate successful and unsuccessful algebra achievement as measured by final year algebra grade. It was found that this predictor was capable of discriminating correctly 83% of the cross-validation group.

This study concludes that there are predictors present that could assist in counseling potential algebra students. Not only could these predictors assist in the course selection process of students in the spring semester when they are registering for classes but also the first nine weeks' algebra grade could serve as a predictor once the school year had begun. This would be yet another attempt to inform students and their parents as to the probability of successful or unsuccessful end-of-the-year algebra achievement.

Considerations for Administrators

The school system in which this study was conducted defines the school principal to be the instructional leader of the building. Floretta McKenzie (1985), D.C. school superintendent, stated that it is the principal who is the key to achievement and that it is the principal who must provide the climate and direction of the school. This study has clearly identified an instructional concern--a high rate of unsuccessful achievement in first-year algebra. How can the school administrator assist in this situation? Several areas need to be examined.

The first area is the placement process itself. The administrator must express interest in the placement process and must emphasize the importance of the placement process. It is imperative that students be assisted in course selection. The administrator must stress that the mathematics selection process is important because some level of competency in mathematics is required for a majority of students to reach their academic goals. Mathematics teachers and guidance counselors must be made aware of the important role they play in this process. There should be a definite plan for deciding which students are to be advised to take first-year algebra. The results of this study conclude that there are easily accessible and available predictor variables that could assist in this selection process. A placement procedure based on these variables should be implemented to counsel students in their selection of algebra. It is suggested that the following plan be implemented. The steps are:

1. In the spring, the Orleans-Hanna Prognosis Test is administered to all potential algebra candidates. (This

test is easy to administer, takes one 50-minute class period, and can be quickly graded by a scan-tron machine. Thus minimal instructional time is lost and teachers and counselors are not burdened with additional tasks.)

2. The mathematics teacher uses the Orleans-Hanna Prognosis Test results and the teacher assigned mathematics grade to determine which students should be advised to take algebra. Borderline cases should be decided by the additional information provided by the 8th grade SRA Mathematics scores.

3. The mathematics teacher counsels with each student and apprises the student of his/her mathematics recommendation.

4. The mathematics teacher submits a list of student names and recommended mathematics courses to the guidance counselor.

5. The guidance counselor reviews the recommendations and informs the teacher of any special considerations that should be noted.

6. The principal sends a letter to any parent whose child wishes to enroll in algebra but was not recommended. The letter informs the parent that:

a. the student has been advised not to take algebra at this time.

b. the ultimate decision rests with the parent.
c. the guidance counselor will schedule a conference if the parent wishes to discuss the matter
d. a signed statement from the parent is required before the student can be scheduled for algebra without a teacher recommendation.

This is a definite plan for a placement procedure that is designed to ensure that administrators, teachers, counselors, parents and students are aware of the importance of the selection process to the achievement of students. An effective placement procedure will alleviate the possibility that a student is placed in an inappropriate environment for learning. It is imperative that the school administrator provide the leadership that is necessary to develop and implement an effective placement procedure.

The second area that needs to be investigated by administrators is that of curriculum. Curriculum implication from this study are:

1. The objectives of the program of studies for the first-year algebra course need to be examined. A review of the course objectives is in order to determine if the content is too difficult for the population or too comprehensive given the allotted time frame. The speed of covering various concepts should be investigated as well as the time that is spent on reinforcement.

2. The program of studies for the 7th and 8th grade mathematics courses needs to be examined. The examination

should include math computation and concept skills, pre-algebra skills, introduction and development of algebraic concepts. The inclusion of various algebra topics and concept analysis is suggested.

3. Development of an additional course, a basic algebra course, that is not as rigorous as the present algebra course but not as decelerated as the two-year algebra program should be considered.

The third area that administrators should examine is instruction.

1. The administrator should determine if between teacher variance in grade distribution exceeds that which might be expected given randomly heterogeneous class assignment.

2. Teacher differences in their perception of standard algebra concepts necessary for future mathematics classes needs to be inspected.

3. Successful teaching methods should be sought.

4. The dropback rate and dropout rate of students from algebra classes should be monitored to ensure that administrative procedures restore class size balance and that teachers with high rates are not rewarded with smaller class sizes.

TABLE 31

Mean 8th Grade Math Scores for
First Semester Algebra Achievement

Semester Algebra Grade: A

	Mean	Standard Deviation
SRA Math Concepts	466	35
SRA Math Computation	533	39
SRA Math Total	524	48

Semester Algebra Grade: B or above

	Mean	Standard Deviation
SRA Math Concepts	460	40
SRA Math Computation	516	37
SRA Math Total	512	44

Semester Algebra Grade: C or above

	Mean	Standard Deviation
SRA Math Concepts	451	41
SRA Math Computation	504	41
SRA Math Total	497	46

5. Administrators need to address the question, "What does it take to get an 'A' or a 'B' or a 'C' in algebra?" The school in which the study was conducted reported that the mean of the SRA Mathematics Total scores for students receiving a semester algebra grade of "A" is 524, "B or above" is 512, and "C or above" is 497. Table 31 provides a more detailed breakdown of the results for this study.

The "normal curve syndrome" is the fourth area the administrator should consider. At a recent management meeting in the school system in which the study was conducted, the mathematics supervisor addressed the issue of the attentuated sample. In essence this means that, after the first grades are reported, low-achieving students are withdrawn and thus the sample size is reduced. However, when the second grades are reported there occurs almost the same percentage of low achievers. This pattern continues. Administrators need to make teachers aware of this phenomenon and need to emphasize that normal curve distributions are not always appropriate.

The final area to be explored is that of assisting the unsuccessful algebra student. This study concluded that a student whose first nine weeks' algebra grade is less than a C has at least a .83 probability of being unsuccessful for the year. Administrators must play an active role in encouraging parent-teacher communication. Counselors should be advised to contact the parents of unsuccessful students and inform them of the extra help provided after school for students. Perhaps outside tutoring is another source of aid to be examined. Re-examination of student records may indicate that misplacement was the culprit from the start. Administrators must design master schedules to accommodate students who need to drop back into other mathematics courses. Properly placed, but underachieving, students must be encouraged to seek extra help and work up to their potential.

Administrators must motivate teachers to motivate students! The role of the administrator is complex. If the principal is to be an effective instructional leader, then the principal must be involved with student achievement. Programs that have high failure rates need to be evaluated and discussed. Administrators must formulate plans to provide workshops and inservices to improve the instructional programs. Special attention should be directed toward the placement process, curriculum development, and instructional techniques.

Recommendations

The following recommendations are made based on the findings of this study.

1. Predictor variables other than the ones used in this study should be tested for strength of predictive ability in predicting successful or unsuccessful achievement

in first-year algebra. Included among the predictor variables should be measures of the student's I.Q., motivational structure, and attitude to succeed in algebra. These variables should increase predictive ability.

2. Due consideration should be given to the results of this study at the participating school when students are being advised in the selection of mathematics courses. Although the accuracy of the predictive tools is not perfect, their utilization is a definite improvement over chance alone.

3. The predictive equations should be evaluated periodically and new equations should be developed.

4. Research should be undertaken to evaluate if the decelerated algebra course is assisting the student who cannot compete or perform successfully in the regular algebra course.

5. A larger longitudinal study should be conducted over a two-year period. The study should investigate variables before the student enters algebra and determine if the placement procedure is adequate for guiding students in their selection of mathematics courses.

6. Other schools should undertake research to develop predictive equations to be used in advising students in the selection of algebra.

APPENDIX A

Instructional Objectives for

First Year Algebra

ALGEBRA 1

Algebra 1 is the first course in the college-preparatory mathematics program. The content of the course includes concepts of exponents; using expressions and equations in one variable; graphs in a coordinate plane; systems of linear equations; polynomials and operations; factoring polynomials; polynomial equations; rational expressions; radicals and irrational numbers; and quadratic equations.

The prerequisites for this course are either General Mathematics 1, Pre-Algebra or Algebra 1, Part 1.

EXPONENTS

1. Write concise, readable expressions using exponential notation.

2. Identify the coefficient, base and exponent of a given power.

3. Multiply given powers with the same base using the property

   $x^m \cdot x^n = x^{m+n}$ (m and n are positive integers)

4. Raise a given power to a power using the property

   $(x^m)^n = x^{mn}$ (m and n are positive integers)

5. Raise a given product to a power using the property

   $(xy)^m = x^m y^m$.

6. Raise a given quotient to a power using the property

   $\left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$ $(y \neq o)$.

7. Divide two given powers with the same base using the property

   $\frac{x^m}{x^n} = x^{m-n}$ $(x \neq 0$; m and n are positive integers)

8. State the definition of x^0 ($x \neq 0$); i.e., x^0 = ($x \neq 0$).

9. State the definition of x^{-m} (m is a positive integer); i.e.,

   $x^{-m} = \frac{1}{x^m}$ (m is a positive integer and $x \neq o$).

EXPRESSIONS

1. Recognize that an open expression represents a real number by evaluating a given open expression using specified replacement values.

2. Write open expressions in a usable form for given situations.

   a. Identify the terms of a given open expression.

   b. Select like (similar) terms from a given list of terms.

   c. Multiply a given open expression by a constant using the distributive property.

   d. Find the opposite of a given open expression.

   e. Simplify a given open expression by using the distributive property to eliminate parentheses and by combining like terms.

EQUATIONS IN ONE VARIABLE

1. Determine solutions of equations in one variable using sets of equivalent equations.

   a. Solve a given equation in the form $ax + b = c$ using the following properties of equality:

      $x = y$, then $x + a = y + a$

      $x = y$, then $ax = ay$

      $x = y$, then $ax = ay$

      $x = y$, then $\frac{x}{a} = \frac{y}{a}$ when $a \neq 0$

b. Solve a given equation in the form ax + b = cx + d using the properties of equality.

c. Solve a given equation by simplifying one or both members and using the properties of equality.

d. State the definition of the absolute value of any real number.

e. Write a compound sentence that is equivalent to a given equation involving absolute value.

f. Solve a given equation involving absolute value which can be written in the form $|ax + b| = c$.

g. Graph a given equation on a number line involving absolute value.

2. Apply mathematics to selected real life situations.

a. Translate given verbal phrases to mathematical equations.

c. Solve selected word problems.

INEQUALITIES

1. Obtain the necessary notation for describing the order of real numbers by using the following symbols of inequality.

$<$, $>$, $\leq$, $\geq$, $\neq$

2. Determine solutions of inequalities using sets of equivalent inequalities.

a. Solve a given inequality in the form $ax + b < c$ using the following properties of inequality:

$x < y$, then $x + a < y + a$

$x < y$, then $x - a < y - a$

$x < y$, then $ax < ay$ when $a > 0$

$ax = ay$ when $a = 0$

$ax > ay$ when $a = 0$

$$x < y, \text{ then } \frac{x}{a} < \frac{y}{a} \text{ when } a > 0$$

$$\frac{x}{a} > \frac{y}{a} \text{ when } a < 0$$

b. Solve a given inequality of the form $ax + b < cx + d$ using the properties of inequality.

c. Solve a given inequality by simplifying one or both members and using the properties of inequality.

d. Write a compound inequality equivalent to a given inequality involving absolute value.

e. Solve a given inequality involving absolute value which can be written in the form $|ax + b| < c$, $|ax + b| > c$, $|ax + b| \leq c$, $|ax + b| \geq c$.

3. Graph the solution of a given first degree compound inequality in one variable.

GRAPHS IN A COORDINATE PLANE

1. Graph the solution set of a given first degree equation which can be written in the form $Ax + By + C = 0$.

2. Graph the solution set of a given inequality which can be written in the form $Ax + By + C < 0$ or $Ax + By + C \leq 0$.

3. Describe some of the characteristics of a line.

   a. Determine the slope of a selected line, given:

      - the coordinates of two points on the line
      - its graph
      - its equation

   b. Determine if a line has a positive, negative, zero or no slope from a graph.

4. Write a given linear equation in the form $y = mx + b$ and recognize that m represents the slope of the line and b represents the y-intercept of the line.

5. Write the equation of a line, given:

   - the slope and y-intercept of the line
   - the slope and the coordinates of a point on the line
   - the coordinates of two points on the line

SYSTEMS OF LINEAR EQUATIONS

1. Display a system of two first-degree equations with two variables.

   a. Graph a given system of linear equations (including inconsistent, dependent, and independent systems).

   b. Graph the union or the intersection of the solution sets of two given linear inequalities.

2. Use an equation in one variable to obtain the solution of a given system of two equations in two variables.

   a. Solve a given system of linear equations by the addition or subtraction method.

   b. Solve a given system of linear equations by the substitution method.

3. Solve selected word problems using a system of equations.

POLYNOMIALS AND OPERATIONS

1. Classify expressions involving powers.

   a. Identify a given polynomial as a monomial, a binomial, or a trinomial.

   b. Find the degree of a given polynomial.

2. Recognize that polynomials represent real numbers and can be operated on.

   a. Add and subtract two given polynomials.

   b. Multiply two given polynomials.

c. Find the quotient of two given polynomials where the degree of the divisor is less than the degree of the dividend.

FACTORING POLYNOMIALS

1. Write the prime factorization of a given monomial.

2. Find the greatest common factor of a given set of monomials.

3. Select the greatest common factor of the terms in a given polynomial and then write the polynomial as the product of this common factor and another polynomial.

4. Factor a given polynomial that can be written as the difference of two squares.

5. Factor a given trinomial that is a perfect square.

6. Factor a given trinomial of the form $ax^2 + bx + c$ where $a = 1$, b and c are nonzero integers.

7. Factor a given trinomial of the form $ax^2 + bx + c$ where a, b, and c are nonzero integers.

8. Write a prime factorization of a given polynomial.

POLYNOMIAL EQUATIONS

1. Solve a given polynomial equation of the form $(ax + b)(cx + d) = 0$ using the property $a \cdot b = 0$ if and only if $a = 0$ or $b = 0$.

2. Solve a given polynomial equation that can be written in the form $ax^2 + bx + c = 0$ where $ax^2 + bx + c$ is a factorable polynomial with a, b and c as integers.

RATIONAL EXPRESSIONS

1. Determine the restrictions on the variable in a given rational expression.

2. Write a given rational expression in lowest terms.

3. Multiply and divide two given rational expressions.

4. Add and subtract two given rational expressions with like denominators.

5. Add and subtract two given rational expressions with unlike denominators.

6. Solve a given equation with fractional coefficients.

7. Solve a given equation involving rational expressions.

RADICALS AND IRRATIONAL NUMBERS

1. Identify the radicand, radical sign, and index of a given radical.

2. Write the exponential form of a given radical.

3. Write the radical form of a given expression involving rational number exponents.

4. Write the square of the integers from 1 through 25.

5. Write each principal square root and negative square root of the positive integers through 625 which are perfect squares.

6. Approximate the principal square root of a positive integer less than 100.

7. State that the square root of a positive integer that is not a perfect square is a nonterminating, nonrepeating decimal.

8. Simplify a given radical by using the following properties:

   a. $ab = a \cdot b \quad (a \geq 0, b \geq 0)$

   b. $\frac{a}{b} = \frac{a}{b} \quad (a \geq 0, b > 0)$

9. Recognize that radicals represent real numbers and can be operated on.

    a. Multiply and divide two given radicals.

    b. Write a given radical expression with a rational denominator.

    c. Add and subtract two given radicals.

d. Solve a given radical equation.

QUADRATIC EQUATIONS

1. Determine solutions of a quadratic equation.

2. Acquire alternative techniques for solving quadratic equations.

    a. Complete the square to solve a given quadratic equation.

    b. Use the quadratic formula to solve a given quadratic equation.

APPENDIX B

Four Item Questionnaire

(Used as the Variable: Study Habits)

PLEASE DO NOT WRITE ON THIS QUESTIONNAIRE

1. I have taken Algebra before, but dropped or did not perform well.

   a) Yes

   b) No

2. I usually spend 20 minutes or more on Algebra outside of class time every day/night.

   a) Yes

   b) No

3. The usual amount of time I spend on Algebra, excluding class time, is approximately (per day):

   a) 15 minutes or less.

   b) 30 minutes.

   c) 45 minutes.

   d) 1 hour.

   e) 1 hour or more.

4. I do my homework in Algebra the night it is assigned.

   a) Under 25% of the days.

   b) Between 25%-50% of the days.

   c) Between 50%-75% of the days.

   d) Over 75% of the days.

PLEASE DO NOT WRITE ON THIS QUESTIONNAIRE

1. I have taken Algebra before, but dropped or did not perform well.

Score 1 → a) Yes

b) No

2. I usually spend 20 minutes or more on Algebra outside of class time every day/night.

Score 1 → a) Yes

b) No

3. The usual amount of time I spend on Algebra, excluding class time, is approximately (per day):

a) 15 minutes or less.

b) 30 minutes.

c) 45 minutes.

Score 1 → d) 1 hour.

e) 1 hour or more.

4. I do my homework in Algebra the night that it is assigned.

a) Under 25% of the days.

b) Between 25%-50% of the days.

c) Between 50%-75% of the days.

Score 1 → d) Over 75% of the days.

APPENDIX C

Mathematics Department's Final

Examination for First Year Algebra

Mark the letter of the correct response on your answer sheet. Do not write on this test booklet. If none of the choices is correct, mark e for the response, none of these.

1. $5 + 6 \bullet 2 - 3 = \underline{\ ?\ }$

a. 19 b. -11 c. 14 d. -1

2. $[-6 + 2(-3 - 2) - 10] = \underline{\ ?\ }$

a. -24 b. -26 c. 25 d. -6

3. The solution set of $2x - 6 = 10$ is $\underline{\ ?\ }$

a. {2} b. {8} c. {12} d. none of these

4. In the expression $-6a^7b$, the 7 is a(n) $\underline{\ ?\ }$

a. exponent b. coefficient c. variable d. factor

5. $6a + 12b - (4a + 6b) = \underline{\ ?\ }$

a. 2a + 18b b. 2a - 6b c. 10a + 6b d. 2a + 6b

6. If n is an integer, the next consecutive integer is $\underline{\ ?\ }$

a. n + 2 b. n + 1 c. n -1 d. n + 4

7. "x + y = 12" in English words says $\underline{\ ?\ }$

a. two numbers are added together.

b. these are only numbers.

c. the answer is twelve.

d. the sum of two numbers is twelve.

8. Translate into an algebraic expression: Twice the sum of a and b.

a. 2 (a + b) b. 2a + b c. 2ab d. a + 2b

9. In $2(x + 5) - 6 = x + 4$, $x = \underline{\ ?\ }$

a. 8 b. 0 c. 4 d. -3

10. Which equation represents the word sentence "Five more than twice the number n is nineteen?"

a. $2(n + 5) = 19$ b. $2(n - 5) = 19$

c. $2n - 5 = 19$ d. $5 + 2n = 19$

11. Solve the equation $2x + 9 = 15$ if $x \in \{0,1,2,3,4,5,6\}$.

a. 3 b. 4 c. 5 d. 6

12. $(a - b)^2 =$ ___?___

a. $a^2 + 2nb + b^2$ b. $a^2 - ab + b^2$
c. $a^2 - b^2$ d. $a^2 - 2ab + b^2$

13. Factor: $m^2 - 6m - 16$

a. $(m - 4)(m + 4)$ b. $(m - 8)(m + 2)$

c. $(m + 8)(m - 2)$ d. $(m - 4)(m - 4)$

14. Factor: $b^2 - 25$.

a. $(b-5)^2$ b. $(b + 5)^2$ c. $(b - 5)(b + 5)$ d. Prime

15. Simplify: $(a^3)^4$.

a. a^{12} b. $4a^3$ c. a^7 d. a^{34}

16. Multiply: $-3a(-4a)$.

a. $7a$ b. $-12a^2$ c. $12a$ d. $12a^2$

17. Which of the following statements is true?

a. $-5 > 0$ b. $-5 > 5$ c. $-5 < 2$ d. $2 < 0$

18. Name the axiom illustrated. $4n + 5 = 5 + 4n$

a. Axiom of closure for addition.

b. Commutative axiom for addition.

c. Associative axiom for multiplication.

d. Commutative axiom for multiplication.

19. Which axiom quarantees that for every real number, n, $(n + 3) + 7 = n + (3 + 7)$?

    a. Commutative for multiplication.

    b. Axiom of closure for addition.

    c. Transitive property of equality.

    d. Associative axiom for addition.

20. $3a\ (6a + 3b) = 18a^2 + 9ab$ is an example of the ___?___ property.

    a. Associative axiom for multiplication.

    b. Commutative axiom for addition.

    c. Associative axiom for addition.

    d. Distributive Property multiplication/addition.

21. Simplify. $-(-6 + |-3|)$

    a. 3 b. -3 c. 9 d. -9

22. Simplify. $4(a + 2) + 6 =$ ___?___

    a. $4a + 14$ b. $4a + 32$ c. $4a + 8$ d. $8a + 6$

23. Find the solution set of $\frac{1}{3}x = -12$.

    a. {-36} b. {-4} c. {36} d. {4}

24. Find the solution set of $4s - 2s - 2 = -42$.

    a. {-42} b. {-20} c. {-22} d. {20}

25. Find the solution set of $29 - 3k = 1 + k$.

    a. {-7} b. {-4} c. {4} d. {7}

26. Simplify: $7x + 1 + 9x + 5$.

    a. $8x + 14$ b. $79x + 6$ c. $63x + 6$ d. $16x + 6$

27. Express the square of $(a + b)$ in exponential form.

    a. $a + b^2$ b. $a^2 + b$ c. $a^2 + b^2$ d. $(a + b)^2$

28. Find the value of $4xy^2 - 2y^3$ if x = 3 and y = -2.

a. 32 b. 64 c. 112 d. -16

29. For the expression $7r^5$, the coefficient is ___?___

a. 7 b. 5 c. r d. 35

30. Simplify: $(4x^2 - 2x + 5) + (2x^2 - 2x - 8)$.

a. $2x^2 + 13$ b. $6x^2 - 3$ c. $6x^2 - 4x - 3$

d. $6x^2 - 4x + 13$

31. Subtract $7a - 5$ from $-2a - 4$.

a. $-9a + 1$ b. $-9a - -9$

c. $5a + 1$ d. $5a - 9$

32. Solve. $5x^2 - 3x = (3x^2 - 7x) + (8x - 2 + 2x^2)$

a. $x = -2$ b. $x = 2$ c. $x = -\frac{1}{2}$ d. $x = \frac{1}{2}$

33. Simplify. $(4x^3y^2)(2y^3)$

a. $8x^3y^5$ b. $5x^3y^5$ c. $2x^3y^6$ d. $8x^3y^6$

34. Simplify. $(a^3b^2)(4ab^4)(ab^2)$

a. $4a^4b^8$ b. $4a^3b^8$ c. $4a^5b^8$ d. $6a^3b^{16}$

35. Simplify. $(-2a^2b^3)^3$

a. $-6a^6b^9$ b. $-6a^5b^6$ c. $-8a^5b^6$ d. $-8a^6b^9$

36. Simplify. $(2n)^3(3n^4)^2$

a. $72n^{11}$ b. $36n^{11}$ c. $36n^9$ d. $6n^{11}$

37. The expression $(\frac{2}{3}x)^3$ is equivalent to ___?___

a. $\frac{6}{9}x^3$ b. $\frac{8}{27}x^3$ c. $\frac{4}{9}x^3$ d. $\frac{3(8)}{27}x^3$

38. A = lw. Solve for l.

a. $l = \frac{A}{w}$ b. $l = Aw$ c. $l = A - w$ d. $l = A + w$

39. What is the value in cents of x quarters and x dimes?

a. $25x + 10$ b. $2x$ c. $10x + 25$ d. $35x$

40. A photo is twice as long as it is wide. The perimeter of the photo is 48 cm. Find the area of the photo.

a. 48 sq.cm. b. 64 sq.cm. c. 128 sq.cm.

d. 240 sq.cm.

41. What is the greatest common factor of 20 and 36?

a. 2 b. 4 c. 180 d. 720

42. Find the prime factorization of 495.

a. $3 \cdot 5 \cdot 11$ b. $3 \cdot 5^2 \cdot 11$ c. $3^2 \cdot 5 \cdot 11$ d. $3^3 \cdot 5^2 \cdot 11$

43. Simplify. $\frac{3a^3}{(6a)^2}$

a. $\underline{a}$ b. $\underline{a}$ c. $\underline{a^2}$ d. $\underline{a\ }$

44. What is the greatest monomial factor of $36x^2y$ and $24xy^2$?

a. $3x - 2y$ b. $6xy$ c. $72xy$ d. $12xy$

45. Simplify. $\frac{6b^3 - 12b^2}{3b^2}$

a. $2b - 4$ b. $2b - 12b^2$ c. $3b - 9$ d. none of these

46. Factor completely. $9x^2 - 64$

a. $(9x + 8)(x - 8)$ b. $(3x + 8)(3x - 8)$

c. $9(x^2 - 6)$ d. None of these

47. Express the product $(3k + 9)(3k - 9)$ as a polynomial.

a. $9k^2 - 27$ b. $9k^2 - 54k + 81$

c. $9k^2 - 81$ d. $9k^2 - 27$

48. Express $(2a - 5)^2$ as a trinomial.

a. $4x^2 - 25$ b. $2a^2 - 10a - 25$ c. $4a^2 - 20a = 25$

d. None of these

49. Factor $6x^2 + 11x - 10$.

a. $(2x - 5)(3x + 2)$ b. $(6x - 5)(x + 2)$

c. $(2x + 5)(3x - 2)$ d. $(x + 3)(6x - 4)$

50. Solve $2x^2 + 3x - 14 = 0$

a. $\frac{2}{7}, 2$ b. $-2, \frac{7}{2}$ c. $2, -\frac{7}{2}$ d. $7, \frac{2}{3}$

51. Express $\frac{3a + 6b}{3a + 3b}$ in simplest form.

a. 3 b. $\frac{3}{2}$ c. $1 + 2b$ d. $\frac{a + 2b}{a + b}$

52. Express $\frac{x - 5}{x^2 - 25}$ in simplest form.

a. $\frac{1}{x - 5}$ b. $\frac{x}{5 - x}$ c. $\frac{1}{x + 5}$ d. $\frac{-x}{x + 5}$

53. Express $\frac{x^2 - 4}{x^2 + x - 6}$ in simplest form.

a. $\frac{x + 2}{x + 3}$ b. $\frac{x - 2}{x + 4}$ c. $\frac{4}{x - 6}$ d. $\frac{2}{x - 3}$

54. Multiply $\frac{8x^2y^3}{3} \cdot \frac{15}{2x^5 y}$

a. $\frac{20y^2}{x^3}$ b. $\frac{120xy}{6x^2}$ c. $\frac{20y^3}{x^3}$ d. $\frac{120x^2y^3}{6x^5 y}$

55. Express $\left(\frac{4x}{y^2}\right)^3$ in simplest form.

a. $\frac{12x^3}{y^6}$ b. $\frac{64x^3}{y^6}$ c. $\frac{12x^3}{y^5}$ d. $\frac{64x^3}{y^5}$

56. Divide. $\frac{x^2y}{7} \div \frac{3x}{14}$

a. $\frac{2y}{3}$ b. $\frac{3x^3y}{98}$ c. $\frac{2x^2y}{3x}$ d $\frac{2xy}{3}$

57. Divide. $\frac{x^2 - 3x - 4}{6} \div \frac{x^2 - 1}{2x - 2}$

a. $\frac{(x-4)}{3}$ b. $\frac{x + 4}{3}$ c. $\frac{x - 4}{6}$ d. $\frac{(x + 4)(x - 1)}{3(x + 1)}$

58. Simplify. $\frac{2x}{3y} \div 4xy$

a. $\frac{8x}{3}$ b. $\frac{3}{8x^2}$ c. $\frac{1}{6y^2}$ d. $\frac{2}{3y^2}$

59. What is the LCD of $\frac{3}{10x}$, $\frac{5}{12x^2}$, $\frac{1}{4y}$?

a. $120x^3y$ b. $120x^2y$ c $60x^3y$ d. $60x^2y$

60. Simplify. $\frac{2n + 3}{4} - \frac{n - 1}{6}$

a. $\frac{4n + 11}{12}$ b. $\frac{4n + 7}{12}$ c. $\frac{8n + 22}{24}$ d. $\frac{8n + 14}{24}$

61. Simplify. $\frac{x}{x - 3} + \frac{3}{x - 3}$

a. -1 b. $\frac{x + 3}{2(x - 3)}$ c. $\frac{x + 3}{x - 3}$ d. $\frac{x - 3}{x - 3}$

62. Simplify. $\frac{3}{5x - 10} - \frac{2}{x^2 - 4}$

a. $\frac{3x - 4}{5(x - 2)(x + 2)}$ b. $\frac{3x + 4}{(5x + 10)(x + 2)}$

c. $\frac{3x + 6 - 10}{x^2 - 4}$ d. $1 - x$

63. Divide. $n - 2 \overline{)\, n^3 - 8}$

a. $n^2 + 2n + 4$ b. $n^2 - 2n + 4$ c. $n^2 + 4$

d. $n^2 - 4$

64. Solve for x. $\frac{1}{4}x - 3 = 9$

a. 48 b. 24 c. 36 d. -48

65. Solve for x. $\frac{3x}{4} + \frac{x}{6} = \frac{11}{3}$

a. 4 b. 2 c. $\frac{1}{4}$ d. $\frac{1}{2}$

66. Solve for x. $\frac{1x}{2} + x = -15$

a. -10 b. 30 c. 5 d. 3

67. Solve for n. $\frac{3n - 1}{5} - \frac{2n - 4}{3} = 1$

a. 2 b. -2 c. 38 d. -38

68. The solution set of the system $\begin{cases} y = 2 \\ x + y = 7 \end{cases}$ is (5,2).
How are the graphs of the two equations related?

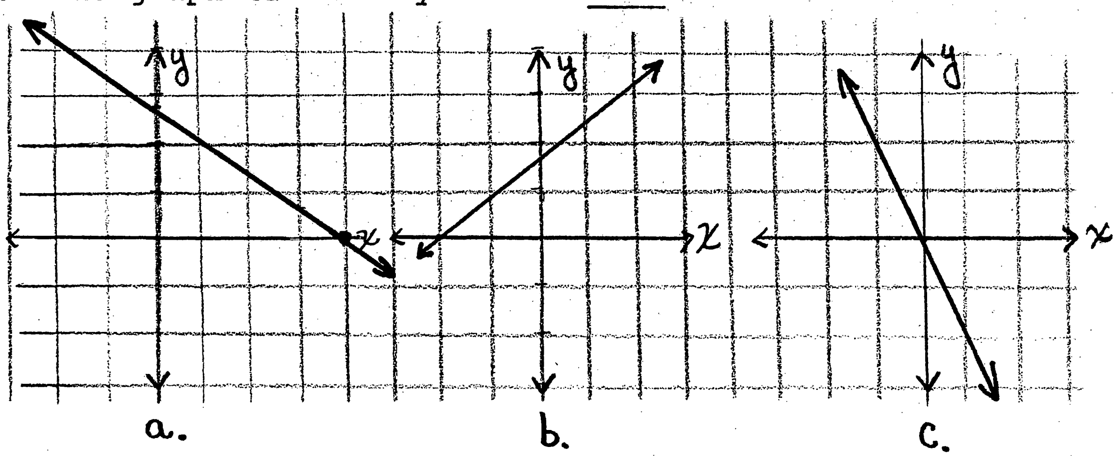
a. The graphs coincide.

b. The graphs are parallel lines.

c. The graphs are lines intersecting in the point (5,2).

d. The graphs intersect in the two points (5,2) and (0,2).

69. The graph of 2x + 3y = 8 is ___?___



70. Which expression can be substituted for y in the second equation of the system $\begin{cases} 2x - y = 1 \\ 2x + 3y = -35 \end{cases}$ in order to solve the system by the substitution method?

a. $2x - y$ b. $1 - 2x$ c. $2x - 1$ d. $\frac{35}{3} - \frac{2}{3}x$

71. Solve by the substitution method. $\begin{cases} 2x - y = 1 \\ 2x + 3y = -35 \end{cases}$

a. (-4,-9) b. (4,9) c. (4, -9) d. (-4,9)

72. Kathy is 31 years younger than her father. The sum of their ages is 47. Find Kathy's age.

a. 16 years b. 8 years c. 39 years d. 11 years

73. Solve by using the addition method. $\begin{cases} 2x - y = 1 \\ x + 2y = 8 \end{cases}$

a. (2,3) b. (3,2) c. (4,5) d. (1,2)

74. In which system of equations can you eliminate one variable by adding similar terms?

a. $\begin{matrix} x + y = 3 \\ 2x + y = -3 \end{matrix}$ b. $\begin{matrix} 3x - 2y = 5 \\ 2x + 2y = -5 \end{matrix}$ c. $\begin{matrix} 2x - 3y = 7 \\ 5x - 3y = 2 \end{matrix}$

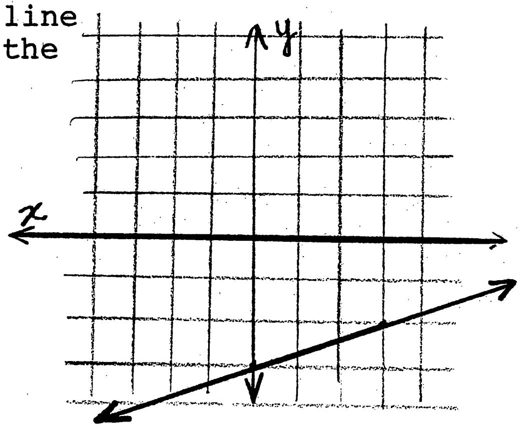
75. A motorboat went 18 km downstream in one hour. The return trip against the current took 3 hours. Find the rate of the current.

a. 18 km/hr b. 6 km/hr c. 12 km/hr d. 3 km/hr

76. Find the slope of the line that passes through the points (-2,4) and (3,-1).

a. $\frac{-3}{5}$ b. -1 c. 0 d. $\frac{1}{3}$

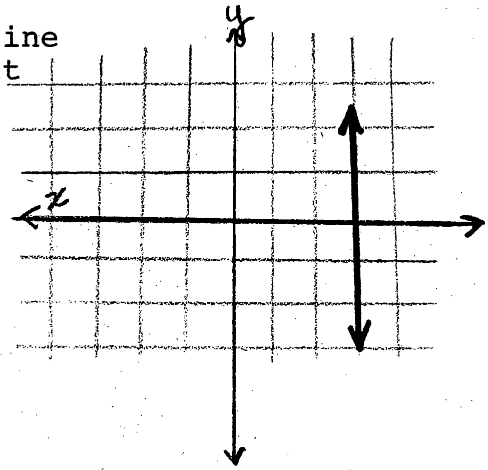
77. Determine the slope of the line by looking at the graph at the right.



a. $\frac{3}{1}$ b. $\frac{1}{3}$

c. $-\frac{3}{1}$ d. $-\frac{1}{3}$

78. Determine the slope of the line that is shown on the graph at the right.



a. positive b. negative

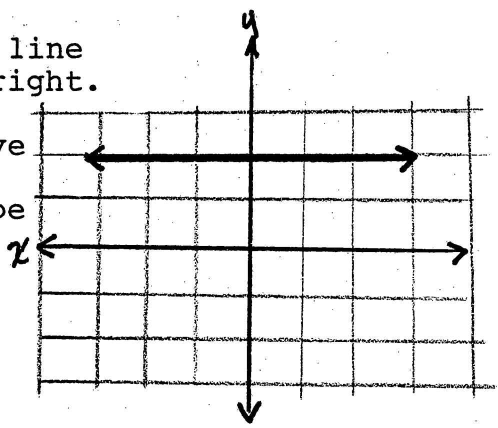
c. zero d. no slope

79. What is the slope of the line whose equation is $y = -\frac{2}{3}x + 2$.

a. $\frac{2}{3}$ b. $-\frac{2}{3}$

c. 2 d. -2

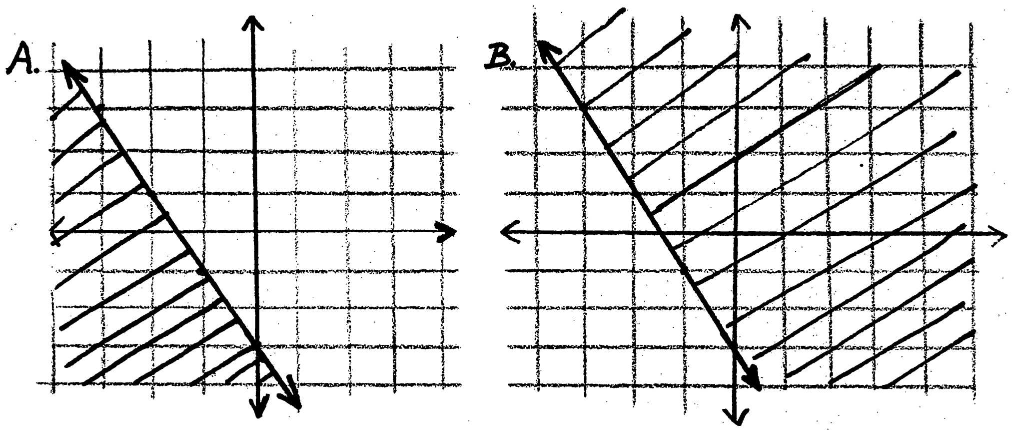
80. Determine the slope of the line shown on the graph at the right.



a. positive b. negative

c. zero d. no slope

81. The graph of the inequality $2x + y \geq -3$ is ___?___ Choose graph A or B shown below.



82. Write an equation for the line whose slope is 3 and whose y-intercept is 2.

a. $y = 2x + 3$ b. $y = 3x - 2$ c. $y = 3x + 2$
d. $y = 2x - 3$

83. Write an equation of the line through the point (2,5) and having a slope of 1.

a. $x - y = -3$ b. $2x + 5y = 0$ c. $y = x - 3$
d. $x + y = 7$

84. Find an inequality equivalent to $\frac{x}{-2} < -6$.

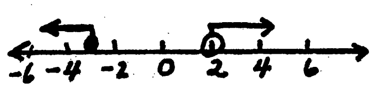
a. $x > 12$ b. $x < 12$ c. $x > 3$ d. $x < 3$

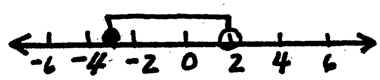
85. Find an inequality equivalent to $4x - 2y \leq 3$.

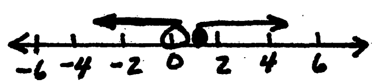
a. $2y \leq 4x - 3$ b. $y \geq 2x - 3$

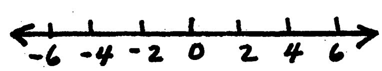
c. $2y - 4x \geq 3$ d. $y \geq -\frac{3}{2}$

86. Which is the graph of the conjunction "$-3 \leq x$ and $x < 2$"?

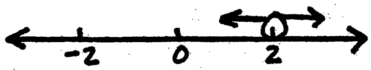
a. 

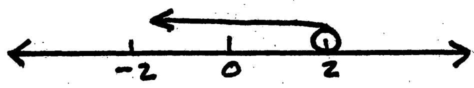
b. 

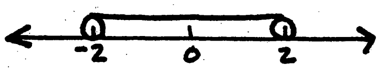
c. 

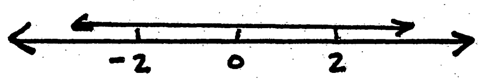
d. 

87. Which is the graph of the solution set of the union "x < 2 or x > 2"?

a. 

b. 

c. 

d. 

88. A compact form of "y < -3 OR y > 3" in ___?___

a. $y > 3$ b. $|y| > 3$ c. $|y| = 3$ d. $|y| < 3$

89. Given: $|y| < 3$. Find the compound inequality equivalent to it.

a. $y < 3$ and $y > -3$ b. $y < -3$ or $y > 3$
c. $-3 > y > 3$ d. $|y| < 3$

90. Solve: $3 - 7x > 45$

a. $x > -6$ b. $x > 6$ c. $x < -6$ d. $x < 6$

91. Find $\sqrt{\frac{121}{100}}$ a. $\frac{13}{10}$ b. $\frac{11}{10}$ c. $\frac{17}{10}$ d. $\frac{21}{10}$

92. Find $\sqrt{1.44}$ a. 1.2 b. 0.12 c. 12 d. 0.012

93. Find $\frac{4\sqrt{3}}{3\sqrt{27}}$ a. $\frac{4}{9}$ b. $\frac{\sqrt{3}}{9}$ c. $\frac{2}{3}$ d. $\frac{4}{27}$

94. Simplify. $\sqrt{96x^4y^6}$

a. $16x^2y^3\sqrt{6}$ b. $x^2y^3\sqrt{96}$ c. $4x^2y^3\sqrt{6}$

d. none of these

95. Simplify. $4\sqrt{2} + \sqrt{32} - \sqrt{16}$

a. $4\sqrt{2} + \sqrt{32} - 4$ b. $8\sqrt{2} - 4$

c. $9\sqrt{2} - 4$ d. $4\sqrt{2}$

96. Multiply. $(2 - \sqrt{5})(2 + \sqrt{5})$

a. -1 b. $4 - \sqrt{5}$ c. $4 - 4\sqrt{5}$ d. -21

97. Nationalize the denominator of $\frac{\sqrt{3}}{\sqrt{5}}$

a. $\frac{\sqrt{15}}{5}$ b. $5\sqrt{3}$ c. $\frac{3\sqrt{5}}{5}$ d. 15

98. Solve $\sqrt{\frac{x - 4}{9}} = 7$

a. 5 b. 445 c. 437 d. 67

99. Solve by completing the square.

$$x^2 + 14x + 24 = 0$$

a. {-12,-2} b. {12,2} c. {12,-2} d. {-12,2}

100. Solve by using the quadratic formula.

$$x + 5x - 8 = 0$$

a. $\frac{-5 + \sqrt{44}}{2}, \frac{-5 - \sqrt{44}}{2}$ b. $\frac{5 + \sqrt{44}}{2}, \frac{5 - \sqrt{44}}{2}$

c. $\frac{-5 + \sqrt{57}}{2}, \frac{-5 - \sqrt{57}}{2}$ d. $\frac{5 + \sqrt{57}}{2}, \frac{5 - \sqrt{57}}{2}$

APPENDIX D

ITEM ANALYSIS OF EXAM QUESTIONS

Item Analysis of 100 Exam Questions

Item	Difficulty Index	Discriminant Index
1	.93	.09
2	.78	.42
3	.03	-.10
4	.90	.20
5	.54	.27
6	.85	.25
7	.98	.18
8	.95	.39
9	.81	.44
10	.92	.30
11	.91	.25
12	.53	.48
13	.74	.43
14	.80	.38
15	.67	.31
16	.79	.31
17	.94	.21
18	.86	.08
19	.55	.17
20	.80	.22
21	.68	.31
22	.93	.29

Item	Difficulty Index	Discriminant Index
23	.75	.43
24	.67	.30
25	.83	.39
26	.95	.32
27	.79	.23
28	.52	.43
29	.59	.25
30	.70	.22
31	.38	.41
32	.45	.47
33	.80	.28
34	.76	.46
35	.62	.38
36	.70	.43
37	.75	.41
38	.73	.42
39	.69	.36
40	.52	.30
41	.77	.21
42	.89	.30
43	.68	.41
44	.56	.28
45	.66	.28
46	.80	.36

Item	Difficulty Index	Discriminant Index
47	.90	.32
48	.65	.49
49	.67	.29
50	.42	.27
51	.39	.27
52	.56	.52
53	.53	.51
54	.66	.27
55	.62	.41
56	.63	.29
57	.41	.43
58	.82	.50
59	.60	.43
60	.27	.29
61	.64	.43
62	.51	.41
63	.23	.24
64	.79	.44
65	.61	.46
66	.72	.41
67	.35	.17
68	.62	.34
69	.51	.21
70	.44	.21

Item	Difficulty Index	Discriminant Index
71	.49	.40
72	.33	.31
73	.65	.38
74	.65	.42
75	.63	-.00
76	.37	.33
77	.32	.29
78	.69	.17
79	.74	.34
80	.44	.31
81	.68	.22
82	.74	.39
83	.18	.09
84	.32	.37
85	.43	.51
86	.61	.21
87	.73	.10
88	.42	.38
89	.43	.27
90	.42	.36
91	.91	.43
92	.64	.44
93	.46	.37
94	.23	.17

Item	Difficulty Index	Discriminant Index
95	.56	.49
96	.35	.44
97	.54	.44
98	.34	.26
99	.31	.25
100	.44	.29

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