A STUDY OF THE RELATIONSHIPS BETWEEN ACHIEVEMENT IN FIRST YEAR MATHEMATICS AND APTITUDE TESTS, PREVIOUS GRADES, AND ACHIEVEMENTS

by

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BACKGROUND FOR THE STUDY

INTRODUCTION

As education becomes more and more specialized, students are finding it necessary to set educational goals in the early years of high school. Objective counseling by guidance workers to aid sound choices on the student's part between algebra and general mathematics depends largely upon the availability of a composite of information from mental ability tests, recommendations by eighth grade mathematics teachers, achievement tests and special purpose prognosis tests. These tests and other data have all been used to predict algebra success. Studies both published and unpublished were concerned with finding some reliable method of predicting satisfactory performance of entering high school students, either as a means of selecting applicants for algebra, elementary algebra or guidance services for students.

PURPOSE

The purpose of the present study was to investigate the relationship of scores on algebra prognosis and aptitude tests, achievement tests, and marks in eighth grade mathematics to achievement in algebra. The problem was to determine the best combination of the instruments for use for advisement purposes

with individual students in determining expectancy of success in algebra. For the purpose of counseling a student with high algebra potential, the chief consideration was that of assuring the student of placement that will result in the maximum development of his capacities. If a student with low ability requests admission to algebra, it was considered to be more profitable to direct the student toward subjects for which his abilities are more suited, by a composite judgment of the teachers, guidance counselor, parents, and the student.

At Bishop Ward High School, Kansas City, Kansas, the students are grouped into algebra or elementary algebra according to their marks in eighth grade and their scores on the mathematics concept section of the Stanford Achievement Test. It would be beneficial to have a reliable criterion by which the membership of the groups could be determined.

If it too frequently happens that a fairly large number of students were permitted to take algebra and failed, it would be a waste of time and money for both the student and the school. If the scores from a suitable prognosis test were available, it would enable the school personnel to help overcome some of the failures due to misassignment and help the school plan a more functional program of mathematics instruction for each student. Thus, there was a need for information that would provide for more accurate placement procedures in the mathematics program at Ward.

With the change in curriculum development that has taken place the last two years at Ward, and with the introduction of team teaching and the emphasis on independent studies by the student, there was a need for a predictive instrument that may be used by teachers as an instructional aid for planning lessons and assignments that will meet the needs of students of different abilities.

The selected factors of the *Differential Aptitude Test* as a predictive indicator were included in this study although they are not given until the beginning of the ninth year. The Differential Aptitude Test was included in this study to determine whether it was of sufficient value as an indicator to merit its administration during the latter part of the eighth grade year.

HYPOTHESES

That there is no significant correlation between the achievement of the first year algebra students measured by the teacher's grade and the selected factors as listed below:

1. Aptitude in Algebra as measured by the Orleans-Hanna Algebra Prognosis Test.
2. Mathematical achievement in eighth grade as measured by the eighth grade mark.
3. Mathematical achievement as measured by the selected Stanford Achievement Test scores: Arithmetic Computation, Arithmetic Concepts, Arithmetic Application, at the end of the eighth grade year.

4. Aptitude in Algebra as measured by the selected Differential Aptitude Test scores: Numerical Ability, Verbal Reasoning, and Numerical Ability plus Verbal Reasoning, at the beginning of ninth grade year.
5. Achievement in first year algebra as measured by the Cooperative Achievement Test.

LIMITATIONS

Limitations of the study that will affect the generality and application of the study to other situations are:

1. Use of only that data available from the school records, and usual testing programs.
2. Exclusion of standardized algebra aptitude test at the end of the eighth grade year.
3. Exclusion of eighth grade teacher recommendations.
4. Administration of the Differential Aptitude Test and the Orleans-Hanna Algebra Prognosis Test at the beginning of the ninth grade. If useful, these tests should be administered at the end of the eighth grade, and may cause a change in the results.

CHAPTER II

REVIEW OF THE LITERATURE

Numerous articles have been written on predicting success in first year algebra in high school, but the prediction of achievement has been complicated by the development of newer curriculum procedures and was incomplete. The need for prediction studies based on local data is advocated quite strongly.[1]

The algebra aptitude tests available for prognosis in modern mathematics courses have not been studied locally as a prediction for achievement of first year algebra.

Who should study algebra and when should this study begin? These were the questions that Dinkel was trying to answer in his investigation of predicting the success in traditional algebra.[2] As an independent variable, the Orleans Algebra Prognosis Test was used. Since the Orleans Test was a test that was tedious to time and slow to score, Dinkel constructed a multiple-choice prognosis test which correlated with achievement in algebra almost as well as the Orleans Test. When the Pretest was doubled to 48 items, it was discovered to have a multiple coefficient of correlation

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[1]Ward E. Barnes and John W. Asher, "Predicting Student's Success in First-Year Algebra," The Mathematics Teacher, 55:651-54, December, 1962.

[2]Robert E. Dinkel, "Prognosis for Studying Algebra," The Arithmetic Teacher, 6:317-19, December, 1959.

equal to .83, which was close to the multiple coefficient of correlation of .86 for the second year. The test was later published under the title of Survey Test of Algebraic Aptitude and showed a coefficient of correlation of .91 for eighth grade and .93 for ninth grade.

The problems presented by Barnes and Asher generally were (1) who shall be advised by the guidance department to take algebra and who shall not, (2) was the recommendation valid in predicting the success in algebra at the ninth grade level.[3]

In this study the selection of students was made on the basis of a large number of variables in a sample of 192 students under six different algebra teachers. The variables are common in most school systems and include such variables as previous grades, achievement test results, IQ test results, and algebra prognostic test results. A multiple-regression equation was developed for predicting the ninth grade algebra grade.

They found that the best single predictor of success was the eighth grade mathematics grade (r=.58). The only other factor which greatly raised the multiple correlation (r=.61) was the grade equivalent on the arithmetic part of the achievement test given at the end of the seventh grade. The Orleans Algebra Prognosis Test

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[3]Ward E. Barnes and John W. Asher, "Predicting Student's Success in First-Year Algebra," The Mathematics Teacher, 55:651-54, December, 1962.

did not detract from their prediction, but neither did it aid it much.

Callicutt supported the previous studies by singling out previous grades as the best predictor of success,[4] reporting a relationship between eighth grade mathematics grades and ninth grade algebra grades (r=.58).

Ivanoff et al. investigated certain data available on 448 freshmen male students at one large Midwestern-suburban high school for information which could be used to assist students in developing their ability for self-appraisal and decision-making concerning their choice of a mathematics program.[5] The purpose of their study was to determine whether, on the basis of available entrance data, it was possible to discriminate between students who successfully completed ninth grade algebra and those who completed the general mathematics program.

There was a total of 286 in the algebra group and 162 in the general mathematics group. The criterion used in this study was successful completion of ninth grade algebra, or completion of the general mathematics course. Using this criterion of algebra

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[4]Wade Callicutt, "The Problem of Predicting Success in Algebra," National Association of Secondary-School Principals, 45:107-11, November, 1961.

[5]John M. Ivanoff, Evermode T. DeWane, and O. Praem, "Use of Discriminant Analysis for Selecting Students for Ninth-Grade Algebra or General Mathematics, The Mathematics Teacher, 58: 412-16, May 1965.

versus general mathematics, an attempt was then made to determine whether or not the predictor variables: IQ, Reading, Arithmetic, Language, and Composite scores from the High School Placement Test could differentiate between the two groups.

In testing the hypothesis that there was no significant difference between the two groups (algebra, general mathematics) and an adaptation of Fisher's discriminant analysis were computed in a stepwise manner. The "best" independent variable was first selected and then the "best" of the remaining variables was selected until all six predictor variables were used in a stepwise procedure. The results showed that it was possible to discriminate between the algebra and general mathematics groups, and the best single predictor was the Composite scores from the High School Placement Test in the eighth grade.

In other studies, Lazarus found that the eighth grade mathematics marks had a coefficient of correlation equal to .747 with marks in algebra, and were the best predictor of algebra marks.[6] Of the students following the teacher's recommendation in algebra, seventy-seven per cent were able to receive at least a C in algebra. Coefficients of correlation equal to .747, .567, .108, and .389 were found between marks in algebra and eighth grade mathematics grades, DAT Numerical Ability results, DAT Verbal Reasoning results,

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[6]Gary J. Lazarus, "The Use of Selected Factors for Prediction of Success in Algebra," (Master's report, Kansas State University, Manhattan, Kansas, 1968), p. 13.

and the DAT Numerical plus Verbal Reasoning results, respectively.[7]

The later reports make use of several predictors in correlating the criteria in modern mathematics and traditional algebra.

Sabers and Feldt studied the predictive validity of the third edition of the Iowa Algebra Aptitude Test for prognosis in ninth grade modern mathematics and traditional courses.[8]

A random sample of eighth grade students whose schools were classified as modern or traditional in regard to their mathematics offerings were given the Iowa Test of Basic Skills, and the Iowa Tests of Educational Development in addition to the Iowa Algebra Aptitude Test. As criterion measures, two 40 minute achievement tests, designed to assess achievement in traditional algebra and modern mathematics, were administered to students who had completed one semester of high school math. It was found that all of the predictor variables correlated significantly with criteria in modern mathematics and traditional algebra and could be used as reliable predictors of achievement in traditional algebra and modern mathematics.

Prediction of algebra achievement by use of algebra prognosis tests, IQ's, teacher predictions, and mathematics grades, was studied

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[7] Ibid.

[8] Darrell L. Sabers and Leonard S. Feldt, "The Predictive Validity of the Iowa Algebra Aptitude Test for Achievement in Modern Mathematics and Algebra," Educational and Psychological Measurement XXVIII, 1968, 901-907.

by Hanna who investigated 1,105 eighth grade mathematics students in nine schools and six states who took the Orleans-Hanna Algebra Prognosis Test in April and May of 1967.[9] This test contains (1) 58 work-sample test items, (2) student-predicted mid-year algebra grades, and (3) student-reported most recent report-card grades in mathematics, science, English, and social studies. Multiple correlations among the variables were computed and three sets of stepwise regression analysis were conducted.

The total prognosis test scores and the scores on its work-sample section were highly correlated, and had .66 to .62 coefficient of correlation with the year-end algebra grades. The teacher's predictions and mental ability test scores added little to the prognosis test's validity in predicting achievement determined by a multiple regression equation.

Contrary to the findings of this study, Barnes[10] and other investigators,[11] using prognosis tests and other predictors, have reported multiple correlations that distinctly exceeded the correlation of the prognosis test when used alone. The findings of Hanna's report was: the use of teacher predictions and mental ability

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[9]Gerald S. Hanna, "Predicting Algebra Achievement with an Algebra Prognosis Test, IQ's, Teacher Predictions and Mathematics Grades," Unpublished Report, Kansas State University, 1968.

[10]Ward E. Barnes and John W. Asher, "Predicting Student's Success in First-Year Algebra," The Mathematics Teacher, 55: 651-54, December, 1962.

[11]Darrell L. Sabers and Leonard S. Feldt, "The Predictive Validity of the Iowa Algebra Aptitude Test for Achievement in Modern Mathematics and Algebra II Educational and Psychological

test scores may be less productive in predicting grades with tests that incorporate student-reported past grades into their total scores than with more conventional special-purpose prognosis tests.

The best predictor of mathematics grade point averages, Jacobs reported, when students were grouped according to sex, was the arithmetic proficiency test, r=.61 for boys (n=107) and r=.67 for girls (n=71).[12] In a study conducted in 1952-1953, Cincinnati Public Schools used the Terman McNeman Test of Mental Ability and an Arithmetic Proficiency Test with the Differential Aptitude Test: Verbal Reasoning Test, Numerical Ability Test, Mechanical Reasoning Test, to find the correlation with the grade point average in three or more high school mathematics subjects.

Correlation with Grade Point Average

	Mental ability	APT	VR	NA	MR	N
Girls	.622*	.671*	.566*	.654*	.506*	71
Boys	.433*	.610*	.379*	.495*	.271*	107

* Significant at .01.

The DAT scores were not recommended for inclusion for the purposes of predicting high school academic success. The

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[12] James Jacobs, "Aptitude and Achievement Measures in Predicting High School Academic Success," The Personnel and Guidance Journal, Vol. 37:341, January 1959.

achievement and intelligence tests in current use were just as effective in predicting academic success.[13] The later studies do not agree with the previous conclusion that DAT scores can be used as a good predictor. Note that (a) all correlations were significant at .01, and (b) DAT NA was second high for both sexes.

In 1963, Osburn and Melton[14] administered four aptitude batteries: the Iowa Algebra Aptitude Test, Orleans Algebra Prognosis Test, the S.R.A. Primary Mental Abilities, and the Differential Aptitude Test. The battery of tests was given to a group in traditional algebra and to an experimental group of students in modern mathematics. The Orleans Algebra Prognosis Test, Iowa Algebra Aptitude Test, and the sum of the Verbal Reasoning and Numerical Ability Scales from the DAT reported all three showing validity of the same magnitude in the predicted proficiency in both courses. The correlation values for all predictors and the final tests in algebra were between .63 and .72.

The Verbal Reasoning and Numerical Ability Sections of the DAT were not equally valid in predicting proficiency for traditional algebra in Cain's study of achievement in algebra as related to these subtest scores. A higher correlation was reported for

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[13] James Jacobs, "Aptitude and Achievement Measures in Predicting High School Academic Success," The Personnel and Guidance Journal, 37:341, January, 1959.

[14] H. G. Osburn and R. S. Melton, "Prediction of Proficiency in a Modern and Traditional Course in Beginning Algebra," Educational and Psychological Measurement, 23:277-87, Summer, 1963.

Numerical Ability and traditional algebra, r=.46, than for Verbal Reasoning and traditional algebra, r=.37.

Rezac, through the use of expectancy tables (N=350), concluded from his study that in order for students to achieve any degree of success in algebra the students should achieve a percentile rank of forty or over on the Numerical Ability test of the DAT battery.[15]

Guilford investigated to find if a combination of four DAT subtests (the Verbal Reasoning, Numerical Ability, Abstract Reasoning, and the Clerical Speed and Accuracy) would yield a high degree of prediction of achievement in courses in ninth grade mathematics as did batteries of the more traditional, standard academic aptitude tests.[16] Multiple correlation coefficients of .53, .24, and .70 were obtained between DAT subtests and achievement scores in three different levels of algebra: non-college algebra, regular algebra, and accelerated algebra. The best multiple coefficients of correlation reported for the aptitude tests were .56, .39, and .75 from a composite of nine additional factor scores for the three levels of algebra, respectively.

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[15] James L. Rezac, "Predicting Success of Ninth Grade Mathematics Students in Manhattan Junior High School," Master's Report, Kansas State University, 1968.

[16] J. P. Guilford, Ralph Hoepfner, and Hugh Peterson, Predicting Achievement in Ninth Grade Mathematics from Measures of Intellectual-Aptitude Factors," Educational and Psychological Measurement, 25:659-82, Autumn, 1965.

For those who must shoulder the responsibilities of developing mathematics programs for their schools, the balance among several variables and their importance in a given program can be measured in predicting achievement of first year algebra students. If emphasis is desired on different aspects of mathematics training at different grade levels or for different types of students, such emphasis might be indicated by employing multiple predictions of achievement.

It has been demonstrated that multiple predictions of achievement in certain courses of study can be greatly improved by bringing together within the predictive battery a number of factors. Investigations have been made to determine whether predictions of achievement in the "new" mathematics courses will take the same kinds of predictor variables as have been found in the traditional courses. Osburn and Melton found that predictions in new and traditional courses were similar, but there was some evidence of interaction of ability and types of courses.[17]

"Indeed there is some general agreement concerning the variables to be used in such prediction schemes, but the weight required for their optimal combination depends upon the local situation."[18]

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[17]H. G. Osburn and R. S. Melton, "Prediction of Proficiency in a Modern and Traditional Course in Beginning Algebra," Educational and Psychological Measurement, 23:277-87, Summer, 1963.

[18]John M. Ivanoff, Dewane T. Evermode and O. Praem, "Use of Discriminant Analysis for Selecting Students for Ninth-Grade

The reports make use of several predictors, and generally conclude that the best single indicator is the previous year's mathematics grade[19], or an aptitude test[20], and the Verbal Reasoning and Numerical Ability scales from the Differential Aptitude Test.[21]

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[19]James C. Shortt, "Predicting Success in Geometry, Algebra II, and Senior Mathematics at Larned High School," Master's Report, Kansas State University, 1964.

[20]John M. Ivanoff, Dewane T. Evermode and O. Praem, "Use of Discriminant Analysis for Selecting Students for Ninth-Grade Algebra or General Mathematics," The Mathematics Teacher, LVIII: 412-416, May 1965.

[21]H. G. Osburn and R. S. Melton, "Predictions of Proficiency in a Modern and Traditional Course in Beginning Algebra," Educational and Psychological Measurement, 23:277-87, Summer, 1963.

CHAPTER III

METHODS AND MATERIALS

The purpose of this study was to determine the relationship of achievement in algebra to various factors used to predict achievement in algebra.

DESCRIPTION OF SUBJECTS

During the 1969-70 school year, a total of 119 students were enrolled in two team-taught ninth grade algebra classes at Bishop Ward High School, Kansas City, Kansas. Since none of these students attended Ward during the previous year, eighth grade mathematics marks were obtained from their previous junior high or grade schools. If the student enrolled during the year, or if the eighth grade mathematics marks were not available for the student, the student was excluded from the study. Complete data for each of the selected factors were not available for 12 students; therefore, the number included in the study was 107 students.

The students were grouped into two classes that were taught by team teaching methods. The material presented to the students was taken from the School Mathematics Study Group, First Course in Algebra textbook and was basically the same in both classes.

DESCRIPTION OF VARIABLES EMPLOYED

The following data were collected for all students:

1. Measure of achievement in first year algebra: teacher-assigned final grades collected from teacher's records.

2. Measure of achievement in first year algebra: scores on the Cooperative Achievement Test collected from teacher's records.

3. Measure of achievement in eighth-grade mathematics: teacher-assigned final grade, collected from school and teacher records.

4. Measure of achievement in mathematics: scores on the Arithmetic Application sections of the Stanford Achievement Test, collected from school records.

5. Measure of algebra aptitude: score on the Orleans-Hanna Algebra Prognosis Test.

6. Measure of achievement in mathematics: scores on Numerical Reasoning, Abstract Reasoning and Numerical Reasoning plus Verbal Reasoning sections of the Differential Aptitude Test Battery, collected from the school records.

One measure of achievement in algebra was the student's grade at the end of the second semester. The grade in algebra was assigned on the basis of a twelve-point scale, with a grade of A in algebra being the equivalent of twelve points, a grade of A- worth eleven points, a grade of B+ worth ten points, and a grade

B worth nine points. Grades of C, D, and F were assigned equivalent values of six, three, and zero points, respectively, with a point being added for a plus grade and a point being subtracted for a minus grade. On the basis of this scoring system, a score of five or better was considered a success in algebra.

PROCEDURE

The Orleans-Hanna Algebra Prognosis Test was administered during the first two days of the first week of the fall semester, to all first-year mathematics students. The Stanford Achievement Test scores, Differential Aptitude Test scores, and the eighth grade marks were available from records supplied by the school. The second semester algebra grades and scores of the Cooperative Achievement Test were obtained from the teacher's records during June, 1970. Results of the prognosis tests were not released to teachers until all criterion data had been collected.

For preparation in the use of the computer, all of the data were collected and filed on punch cards. The data were then submitted to the computer center, according to the format of the 360 multiple regression with variable generation program obtained from Dr. John Roscoe of the College of Education at Kansas State University. For the variables used, a multiple regression equation was set up for the eighth grade marks, S.A.T. test scores, DAT test scores, and the special prognosis test that gave the highest correlation with the algebra grades and the Standardized Achievement Test.

CHAPTER IV

FINDINGS

Examination of the correlation matrix revealed that all of the variables used were found to be significantly (at the .01 level of confidence)[1] related to achievement in Algebra I and to the student score on the Cooperative Achievement Test (Table I). The largest coefficients of correlation, r=.63, were found between VR + NA factors from the Differential Aptitude Test Battery and achievement in Algebra I, and between the same independent variable and the Cooperative Achievement Test, r=.62.

The comparison of the selected variable with the algebra marks results in a variety of relationships. The Orleans-Hanna Algebra Prognosis Test and the Arithmetic Computation on the Stanford Achievement Test resulted in a value of r=.566 when compared with algebra marks.

The Orleans-Hanna Algebra Prognosis Test shows a slight indication of being a better predictor of achievement in Algebra I than the Arithmetic Computation section of the S.A.T. (Table I). The Orleans-Hanna Test was found to rank second as a predictor for achievement in Algebra.

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[1]Richard P. Runyon, Audrey Haber, Fundamentals of Behavioral Statistics, (Reading, Massachusetts) Addison-Wesley Publishing Company, p. 259, 1969.

TABLE I

SIMPLE CORRELATION MATRIX FOR THE POPULATION

N = 107

Variable	Comp	Concpt	Appl	O-H	8th Math	NA	AR	VR+NA	Alg I	CAT
Comp	1.0000									
Concpt	0.7308	1.000								
Appl	0.4277	0.4375	1.000							
O-H	0.5891	0.4579	0.4007	1.000						
8th Math	0.4935	0.3504	0.3115	0.5511	1.000					
NR	0.6552	0.6107	0.5401	0.6039	0.4260	1.000				
AR	0.2300	0.2644	0.3373	0.4328	0.2535	0.4151	1.000			
VR+NA	0.5670	0.5710	0.5887	0.6444	0.4911	0.7874	0.4275	1.000		
Alg I	0.5658	0.4981	0.3891	0.5661	0.4337	0.5080	0.3602	0.6270	1.000	
CAT	0.5238	0.5141	0.4598	0.5424	0.3988	0.5719	0.3935	0.6205	0.7408	1.000
Significant at the .01 level of confidence = .230										
Means	56.364	52.439	59.280	47.364	8.178	58.776	64.636	69.589	5.645	56.477
Standard deviation	26.514	23.349	22.573	23.273	2.225	23.322	22.899	19.645	2.826	29.555

The VR, NA, and VR + NA factors from the Differential Aptitude Test Battery all exhibited a fair degree of relationship to Algebra I achievement, with the VR being significantly related to the achievement in algebra and achievement on the Standardized Achievement Test (r=.51 and r=.57). The AR gave coefficients of r=.36 and r=.39 to achievement in algebra and achievement on the Standardized Achievement Test, respectively. As stated previously, the VR + NA factor was found to rank first as an index to future achievement in algebra.

The Arithmetic Computation, Arithmetic Concepts, and the Arithmetic Application factors from the Stanford Achievement Test also exhibited a variety of relationships with both dependent variables. The Arithmetic Computation, Arithmetic Concepts, and the Arithmetic Application sections of the tests resulted in values of.57, .50, and .40, respectively, when compared with algebra marks. The same factors, when correlated with the Standardized Achievement Tests produced coefficients of .52, .51, and .46, respectively.

The relationship of the eighth grade marks to the criterion is somewhat conspicuous. However, it shows a slight indication of being a better predictor of achievement for algebra than it does for the Standardized Achievement Test, an r=.42 compared with an r=.40.

With the yearly grades in Algebra I as the criterion variable (Y_1), and Cooperative Achievement Test as the criterion

variable (Y_2), combinations of the following factors were investigated for their predictive value:

X_1: Arithmetic Computation Score, SAT

X_2: Arithmetic Concepts Score, SAT

X_3: Arithmetic Application Score, SAT

X_4: Orleans-Hanna Algebra Prognosis Test Score

X_5: Eighth Grade Arithmetic Grade

X_6: Numerical Reasoning Score, DAT

X_7: Abstract Reasoning Score, DAT

X_8: Verbal Reasoning plus Numerical Ability Score

When the data for the population were subjected to the multiple regression scheme, the equation formulated for the maximum prediction of the criteria was:

$$Y_1 = 0.0292X_1 + 0.0079X_2 + -0.0019X_3 + 0.0184X_4 + 0.0508X_5 + -0.0245X_6 + 0.0130X_7 + 0.0633X_8 + -1.3940$$

and

$$Y_2 = 0.1145X_1 + 0.1657X_2 + 0.1119X_3 + 0.1685X_4 + 0.4126X_5 + 0.0369X_6 + 0.1501X_7 + 0.3968X_8 + -16.1431.$$

The multiple coefficients of correlation obtained between the combination of eight independent variables and the criteria were .7043 and .6862, respectively (Table II). By squaring these values, it can be seen that these combinations account for approximately fifty per cent of the variance shown by the ninth grade

TABLE II

PREDICTIVE VALUES FOR MULTIPLE REGRESSION EQUATION

Independent variable	Alg I Grade		Coop Ach Test	
	Multiple-R	R-Sq	Multiple-R	R-Sq
X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8	0.7043	0.4960	0.6862	0.4709
X_1, X_4	0.6349	0.4031	0.5985	0.3581
X_1, X_5	0.5930	0.3516	0.5481	0.3004
X_1, X_6	0.5942	0.3531	0.6050	0.3660
X_1, X_8	0.6769	0.4583	0.6547	0.4286
X_4, X_5	0.5846	0.3417	0.5555	0.3086
X_4, X_6	0.6033	0.3639	0.6230	0.3882
X_4, X_8	0.6618	0.4380	0.6479	0.4198
X_5, X_6	0.5619	0.3157	0.5970	0.3564
X_5, X_7	0.5050	0.2550	0.5004	0.2504
X_6, X_7	0.5339	0.2850	0.5921	0.3565
X_6, X_8	0.6274	0.3936	0.6350	0.4033
X_1, X_2,X_3	0.5960	0.3552	0.6023	0.3627
X_1, X_4, X_8	0.6893	0.4751	0.	
X_4, X_6, X_8	0.6621	0.4385	0.6554	0.4296
X_1, X_4, X_6, X_8	0.6963	0.4848	0.6672	0.4451

yearly algebra grade and forty-seven per cent of the variance shown by the Standardized Test score.

Since the VR + NA score showed the greatest relationship or largest coefficient of correlation with algebra grades for both groups, it was selected first, then the independent variables were placed in competition with each other for inclusion in the predictive scheme for Algebra I.

A combination of the VR + NA scores and Orleans-Hanna Test scores produced a multiple R of .66, not a noticeable decrease from that obtained with all independent variables. The multiple regression equation formulated for the group based on these two variables was

$$Y_1 = 0.0337X_4 + 0.0645X_8 + -0.4375.$$

The multiple R obtained from a combination of the VR + NA scores and Arithmetic Computation scores was r=.68 and was the highest multiple R obtained from a combination of the two most contributing predictive variables. The multiple regression equation formulated for the group based on these two variables was

$$Y_1 = 0.0330X_1 + 0.0649X_8 + -0.7341.$$

The highest multiple R obtained from a combination of the other pairs of independent variables for the prediction of Algebra I grades, was Arithmetic Computation scores and Orleans-Hanna test scores, r=.63, Arithmetic Computation scores and eighth grade mathematics scores, r=.59, and NA scores and NA + VR scores, r=.63.

The multiple R obtained from a combination of the three most contributing predictive variables for Algebra I was .69. Forty-eight per cent of the variance shown by the dependent variable is accounted for by the variance in a combination of the Arithmetic Computation scores, Orleans-Hanna test scores and VR + NA scores. The prediction equation formulated from these factors was

$$Y_1 = 0.0266X_1 + 0.220X_4 + 0.530X_8 + -0.5873.$$

The effectiveness of two prediction equations using the independent variables, (1) VR + NA section of the DAT and the Orleans-Hanna, (2) VR + NA sections of the DAT and Arithmetic Computation section of the SAT, and (3) the Orleans-Hanna and Arithmetic Computation section of the SAT, was compared to determine whether the two-predictor equation produces significantly better predictor than the single-predictor equation.

The calculated F-ratio for the two-predictor equations produced significance of 7.71, 3.91, and 6.36, respectively. The calculated F-ratio is nonsignificant,[2] indicating that the two-predictor equations are not significantly better than the single-predictor equation (Table III).

The F-ratio was calculated from:

$$F = \frac{\frac{R^2_{fm} - R^2_{rm}}{u-v}}{\frac{1-R_{fm}^2}{N-u-1}}$$

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[2]John T. Roscoe, Fundamental Research Statistics, Holt, Rinehart and Winston, Inc., New York, 1969: 322.

TABLE III

THE COMPARISON OF THE EFFECTIVENESS OF PREDICTING EQUATIONS

Equations	R	Number of predictors
All tests	.7043	8
SAT: Arith. Comp.	.5658	1
O - H	.5661	1
DAT: VR + NA	.6270	1
SAT: A. COMP. plus O - H	.6349	2
SAT: A. COMP. plus DAT: VR + NA	.6769	2
O - H plus DAT: VR + NA	.6678	2

F TESTS

	SAT Arith. Comp.	O - H	DAT VR - NR	Degrees of freedom
All Test	4.91	4.87	2.86	1,7
	Arith. Comp. & O - H	Arith. Comp. & VR + NA	O - H & VR + NA	df
All Test	3.03	1.79	1.76	2,7
	Arith. Comp.	O - H		
SAT: Arith. Comp. & O - H	6.36	14.4		1,2
	Arith. Comp.	VR + NA		
SAT: Arith. Comp. & DAT: VR + NA	3.91	6.49		1,2
	O - H	VR + NA		
O - H & DAT: VR + NA	7.71	8.31		1,2

None of these were significant at the .05 level.

where u is the number of predictors in the full model and v is the number of predictors in the restricted model.[3] The prediction equation using all of the predictors will be referred to as the full model (fm) and the equation with fewer predictors as the restricted model (rm).

Calculating the F-ratio for all tests and the DAT:

$$\text{NR + NA:} \quad F = \frac{\frac{.4960 - .3931}{8-1}}{\frac{1-.4960}{107-8-1}} = \frac{.1029}{.5040} \times \frac{98}{7} = 2.86$$

with degrees of freedom = (1,7). The calculated F-ratio is non-significant[4], indicating that the prediction equation using all of the predictors was not significantly better than the single-predictor equation.

Table IV shows what might be expected from the student entering algebra, on the basis of his previous scores on the VR + NA section of the DAT. From Table III, it is apparent that success in algebra can be predicted for a student receiving a percentile ranking of 65 or higher. The student with a percentile ranking of less than 45 is predicted to be unsuccessful in algebra.

Tables V and VI indicate what might be expected from the student entering algebra, on the basis of his previous scores

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[3] Ibid., p. 277.

[4] Ibid., p. 322.

TABLE IV

A COMPARISON OF VR + NA SCORES
WITH RESPECT TO ALGEBRA GRADES

DAT NA + VR per-centile	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F	Success / Total	Percent of success
95	3	1	1	2	1		3						11/11	100
90			2	3	4	1	2		1	1			12/14	86
85	1		1	1		3		1	1	1	1		7/10	70
80	1			1	1	3			3				6/9	67
75					1		4	3	1		2		8/11	74
70						2	1	1		1			4/5	80
65			1	1	1		1	1	1	1	1		5/8	63
60				1			1	2	2	1	1		4/8	50
55							4			1	3		4/8	50
50							1	1		1	3		4/6	33
45							1		1	1	1		1/4	25
40								1		5	1		1/7	14
35										1		1	0/2	00
30										1			0/1	00
25										2			0/2	00
20														0
15														0
10											1		0/1	00
5														0

TABLE V

A COMPARISON OF ORLEANS-HANNA SCORES
WITH RESPECT TO ALGEBRA GRADES

O - H percentile	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F	Success / Total	Percent of success
95	1						1						2/2	100
90				1			1						2/2	100
85			1	2		1	1						5/5	100
80	1						1		1				2/3	67
75			1		1								2/2	100
70		1	2	1		2	1	2			1		9/10	90
65	1						1		1				2/3	67
60			1		1	1	2			2			5/7	71
55				3	2		1		1				6/7	85
50						2		2					4/4	100
45					2		2	2	1	5			6/12	50
40	1				1	1	5	1		3	1		9/13	69
35				1	1		1	1	1				4/5	80
30	1			1				1		1	3		3/7	43
25									1		1		0/2	00
20							2	1		3	1		3/7	43
15						1	1		1	3	2		2/8	25
10										4	4		0/8	00
5												1	0/1	00

TABLE VI

A COMPARISON OF ARITH. COMPUTATION SCORES WITH RESPECT TO ALGEBRA GRADES

SAT Arith. Comp. percentile	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F	Success / Total	Percent of success
95	2			1	2	3	2	1					11/11	100
90			1	1			1						3/3	100
85	1				2		4						7/7	100
80			2					1					3/3	100
75				1	1								2/2	100
70				1	2	1	5	1		3			10/13	76
65		1	1	2			2		2		1		6/9	67
60	1					1		1		1	1		3/5	60
55				1			2			1			3/4	75
50					1		1	2		1			4/5	80
45							1		2	2	1		1/6	16
40				1		2				3			3/6	50
35	1		1				1		1	2			3/6	50
30							1	1	1	2	1		2/6	33
25								1		2	3	1	1/7	14
20				1							2		1/3	33
15							1	1		2	1		2/5	40
10										1	1		0/2	00
5								1			1		1/2	50
0											1		0/1	00

on the Orleans-Hanna and the Arithmetic Computation section of the SAT, respectively. A percentile ranking of 50 on both tests is needed for predictable success in algebra; a percentile ranking of 35 on both tests would indicate failure in algebra (Tables IV and V).

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS OF THE STUDY

These conclusions drawn from the findings of this study are most applicable to the particular school system involved. Other variables that were excluded from this investigation, such as other standardized algebra aptitude test and teacher recommendations, the best criteria found for prognosis in algebra, might have differed. The following conclusions are submitted in view of the variables used and the results of this study:

1. To reject the null hypothesis that there is no significant correlation between the selected factors in this study and achievement in algebra.

2. The DAT: VR + NA scores is the best single factor for predicting future achievement in Algebra 1.

3. The scores from the Differential Aptitude Test of Numerical Ability plus Verbal Reasoning, scores from Stanford Achievement Test: Arithmetic Computations, and Orleans-Hanna Algebra Prognosis Test have a significant positive correlation with the algebra marks.

4. The correlation with algebra marks and the eighth grade mathematics grade scores is not as high as the correlation coefficients for the other factors used for predicting future ninth grade algebra grades.

5. A combination of more than one variable, although better than those based on a single variable for efficiency in predicting success in ninth grade algebra, but does not add significantly to the correlation coefficient.

6. A percentile ranking of more than 45, 35, and 35, respectively, on the VR + NA, Orleans-Hanna and Arithmetic Computation of the SAT is desirable for admission to Algebra.

RECOMMENDATIONS

These findings reveal that the use of the Differential Aptitude Test, the Orleans-Hanna Prognosis Test, the Arithmetic Computations of the Stanford Achievement Test is suitable for predicting success in algebra.

On the basis of the review of literature and the results of this study, the following recommendations are made:

1. The Differential Aptitude Test or the Orleans-Hanna Test be given to the incoming ninth grade students at the end of their eighth year in school.

2. Since the eighth grade mathematics scores are assigned by a variety of teacher evaluation methods, their use as a predictive instrument should be limited.

3. Since a combination of more than one variable does not significantly add to the efficiency in predicting success in algebra, the author recommends the use of only one of the three (VR + NA section of the DAT, Orleans-Hanna, or the Arithmetic Computation of the SAT) for predicting success in algebra.

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APPENDIX

TABLE VII

ORIGINAL DATA

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
1	96	68	80	87	9	85	65	85	7	95
2	22	54	86	33	6	45	90	80	9	87
3	38	42	42	83	9	25	90	65	4	55
4	26	34	42	45	9	40	85	65	3	62
5	52	38	58	41	9	60	75	70	3	55
6	34	42	58	31	6	60	75	75	2	39
7	82	28	42	60	11	27	31	65	10	72
8	26	46	92	13	7	80	75	85	1	77
9	70	58	36	47	8	60	35	75	3	10
10	46	58	76	31	7	65	50	75	2	6
11	42	46	89	85	6	70	99	85	9	72
12	98	72	54	51	9	70	65	85	7	72
13	38	38	18	22	6	50	25	75	6	49
14	70	77	64	77	9	60	65	70	6	49
15	42	34	34	16	6	20	45	35	3	8
16	66	64	54	11	6	65	35	55	2	10
17	78	84	58	58	10	75	90	75	8	39
18	26	28	58	5	6	25	60	35	1	10
19	70	58	64	14	7	45	25	55	6	49

TABLE VII (cont'd)

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
20	52	23	70	45	9	65	5	75	5	14
21	46	46	42	47	5	40	70	40	3	10
22	92	68	54	94	9	90	70	90	9	92
23	98	92	98	51	9	85	80	75	5	72
24	74	58	58	17	6	35	40	40	3	20
25	74	58	36	35	9	60	55	65	9	72
26	46	64	54	45	6	50	3	55	6	49
27	66	68	89	41	4	75	55	75	6	62
28	62	28	54	33	6	10	65	25	3	2
29	82	96	70	37	6	50	40	60	5	25
30	52	68	54	65	9	85	75	85	5	25
31	66	68	58	72	12	70	50	60	4	49
32	8	23	30	33	9	50	60	70	5	49
33	86	38	64	56	10	60	70	80	6	80
34	74	46	42	70	9	65	70	75	5	25
35	30	34	18	43	9	50	65	30	3	25
36	42	38	54	63	6	80	80	70	7	80
37	12	18	36	31	3	50	50	50	2	32
38	66	42	80	68	9	80	85	90	4	49
39	56	58	36	56	6	70	60	75	6	80
40	18	23	76	33	6	30	65	40	5	62

TABLE VII (cont'd)

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
41	86	72	36	63	9	70	35	55	6	72
42	66	54	58	56	9	70	55	60	9	90
43	42	64	12	14	6	25	45	25	3	39
44	26	42	54	12	6	40	80	40	3	6
45	38	54	58	31	9	65	65	85	12	90
46	22	18	36	11	6	35	55	60	2	10
47	62	38	58	47	7	60	65	60	5	45
48	96	42	92	51	6	70	90	70	7	87
49	74	84	36	74	9	97	60	80	7	95
50	12	14	42	16	9	45	45	50	2	0
51	66	54	70	70	10	80	99	95	11	99
52	96	98	89	85	12	85	99	97	9	92
53	46	42	58	47	9	70	45	85	4	20
54	74	58	54	81	12	75	55	90	6	55
55	30	42	54	42	9	50	85	50	5	80
56	62	58	86	65	10	75	75	80	12	87
57	16	10	12	21	6	15	30	40	3	20
58	86	89	96	41	12	90	99	97	12	94
59	34	28	18	35	6	15	95	45	6	8
60	56	46	58	24	9	40	65	50	6	72
61	52	38	42	41	9	20	75	55	6	45

TABLE VII (cont'd)

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
62	66	77	86	56	12	75	99	95	9	90
63	4	6	58	72	4	25	75	55	2	14
64	52	5	76	37	5	65	25	80	8	97
65	38	58	58	70	9	45	60	85	10	83
66	74	77	30	41	5	45	70	65	8	77
67	62	77	80	72	12	24	38	85	7	90
68	18	18	70	14	10	30	3	40	3	10
69	10	10	64	11	5	30	45	45	3	32
70	46	77	89	63	9	65	60	80	3	72
71	18	18	18	13	6	15	20	40	2	20
72	89	77	92	41	9	85	99	95	6	62
73	66	54	64	85	12	75	65	80	6	55
74	86	77	70	56	9	90	60	90	8	62
75	74	68	76	49	9	80	90	90	8	98
76	38	28	80	63	9	65	85	80	3	39
77	18	18	54	16	9	10	50	65	6	32
78	99	96	94	95	12	97	90	97	12	98
79	34	68	64	28	8	70	60	75	4	25
80	66	38	89	79	9	80	80	90	10	95
81	99	89	70	77	12	80	97	95	8	72
82	46	58	70	37	9	40	60	60	4	83

TABLE VII (cont'd)

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
83	98	77	86	41	7	60	30	60	6	71
84	86	38	80	96	12	80	80	90	6	55
85	8	10	42	20	6	30	40	45	2	20
86	56	54	70	72	9	85	95	90	9	80
87	70	54	64	41	8	75	55	95	6	72
88	94	68	64	90	9	85	85	80	6	87
89	96	94	42	65	12	97	95	95	6	67
90	82	80	54	85	12	80	70	90	10	90
91	70	42	54	49	6	55	40	75	6	55
92	22	58	54	28	6	10	75	50	2	10
93	30	34	30	20	6	35	85	55	3	14
94	94	84	98	74	9	97	99	95	10	95
95	42	77	42	41	3	75	90	90	7	80
96	78	38	76	56	9	85	97	90	9	94
97	98	64	80	63	10	80	65	90	8	94
98	56	84	80	45	6	70	55	90	3	83
99	26	46	93	41	8	75	85	65	2	62
100	62	42	24	17	9	50	40	55	2	45
101	38	4	54	41	12	50	75	50	3	67
102	99	96	94	81	9	90	99	95	12	94

TABLE VII (concluded)

Student	Arith Comp	Arith Concpt	Arith Appl	Orleans-Hanna	8th grade	DAT NA	DAT AR	DAT NA+VR	Alg	Coop ACH
103	26	38	12	21	7	20	55	65	5	62
104	74	77	86	49	9	65	50	85	3	55
105	42	18	24	21	6	75	75	60	3	25
106	26	34	6	16	6	25	60	10	2	67
107	89	86	86	49	12	80	80	90	8	87

A STUDY OF THE RELATIONSHIPS BETWEEN ACHIEVEMENT IN FIRST YEAR MATHEMATICS AND APTITUDE TESTS, PREVIOUS GRADES, AND ACHIEVEMENTS

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The purpose of this study was to test the null hypothesis that there was no significant correlation between the selected factors and the achievement of the first year Algebra I students measured by the teachers' grades. The factors were: (1) Aptitude in Algebra as measured by the Orleans-Hanna Algebra Prognosis Test, (2) Eighth grade mathematics marks, (3) Selected Stanford Achievement Test (SAT) scores: Arithmetic Computation, Arithmetic Concepts, and Arithmetic Application, and (4) selected Differential Aptitude Test (DAT) scores: Numerical Ability (NA), Verbal Reasoning (VR), and Numerical Ability plus Verbal Reasoning (NA+VR).

The data were collected from the school records at Bishop Ward High School and the teachers' records during the school years, 1969-1970. The correlations were computed using the Pearson Product Moment Correlation Coefficient and tested for significance. The predictive power of combining the independent variables was determined by a multiple regression analysis.

On the basis of this study the writer rejected the null hypothesis. All of the variables used were found to be significant (at the .01 level of confidence) to achievement in Algebra I and to the Cooperative Achievement Test. The DAT scores, VR + NA, were the best single factor for predicting achievement in Algebra I, $r=.627$, and the scores from the Arithmetic Computation from the SAT, and the Orleans-Hanna Algebra Prognosis Test have a significant positive

correlation with the algebra marks. The corresponding coefficients of correlation were .566, and .566, respectively. A combination of more than one variable was not significantly better than those based on a single variable for efficiency in predicting algebra achievement to make it economical to use a multiple regression equation.

Since the eighth grade mathematics scores are assigned by a variety of teacher evaluation methods, their use as a predictive instrument should be limited.