GEOMETRY GRADES: A PREDICTOR OF ACHIEVEMENT IN PHYSICS AND CHEMISTRY IN TOPEKA PUBLIC SCHOOLS, TOPEKA, KANSAS

by

ROGER LEE DIRKS

B. S., Bethany College, 1963

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

Approved by:

Russel G. Drumright
Major Professor

ACKNOWLEDGEMENTS

The writer wishes to express his appreciation for the guidance and assistance given by Dr. Russel G. Drumright, Associate Professor of Education at Kansas State University, Manhattan, Kansas; Dr. Owen Henson, Principal of Topeka West High School, Topeka, Kansas; and Emmett Larson of the Computer Center of Kansas State University, Manhattan, Kansas; in the preparation of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

For a number of years the students who entered the physics and chemistry classes in the Topeka Public High Schools, Topeka, Kansas, were expected to have previously attained at least a C average in geometry. The basis of this procedure was the assumption that a geometry grade was a good predictor of achievement in physics and chemistry. This method of prediction was used to efficiently regulate enrollment in the physics and chemistry classes so only those students capable of doing acceptable work would take the courses.

In the many studies on academic achievement, there has been strong evidence which indicated that high school grades were the single best indicator of college success.[1] In addition, various studies showed that a grade in a mathematics course was a good predictor of success in later mathematics courses.[2] Even though the studies in academic achievement have been numerous, correlations between various subject matter areas, such as geometry, physics, and chemistry, have not been significantly investigated. This lack of sufficient information and verification of geometry grades as a predictor of achievement

---

[1]Joseph Paul Giusti, "High School Average as a Predictor of College Success: A Survey of the Literature," College and University, 39:200, Winter, 1964.

[2]Donald J. Dessart, "Mathematics in the Secondary School," Review of Educational Research, 34:307-308, June, 1964.

in physics and chemistry led to the study of the following problem.

The Problem

It was the purpose of this study to determine if a geometry grade was a good predictor of achievement in physics and chemistry in the Topeka Public High Schools, Topeka, Kansas. The Differential Aptitude Test scores and geometry grades were used to develop multiple regression equations which described the predictiveness of physics and chemistry achievement.

The hypotheses were: (1) There will be a substantial positive correlation between geometry achievement and physics achievement, and (2) there will be a substantial positive correlation between geometry achievement and chemistry achievement.

Definitions of Terms Used

Achievement. The grade received in a particular course is the achievement of that course.

Grade. The sum of both semesters' point scores issued for a particular subject is the grade of that subject.

Letter score. The letter A, B, C, D, or F issued as a report for each semester's work in a subject is the letter score of that subject.

Point score. Let four points correspond with A, three points with B, two points with C, one point with D, and zero points with F, where A, B, C, D, and F represent letter scores. The number corresponding to a particular letter grade is the point score.

CHAPTER II

REVIEW OF THE LITERATURE

Predicting Academic Success

In recent years there has been an increased interest in predictions. This may be attributed to growth in student populations, growth of programs to identify students with outstanding abilities, development within the social sciences of serious study of education, and an increase in available financial support for research. Most prediction research has been concerned primarily with intellectual and ability factors as predictors. However, there appears to be a shift to nonintellectual characteristics such as personality. This shift is partially attributed to the questioning of value judgements for performance criteria.

The major measures of ability and achievement have been school marks, standardized achievement tests, general intelligence tests, specialized aptitude tests, and standardized test batteries. These tests are measures of intellectual and ability factors. The instruments for measuring factors have not yet been satisfactorily determined.

The improvement of predictor factors is important since prediction of success is necessary for the secondary school, higher education, and occupations. Better prediction would mean less waste of talent and money as well as reduce the inconvenience and frustration due to unsuccessful placement.

In order to understand the prediction of academic success, it is necessary to investigate the meaning of academic performance and the problems of its measurement and prediction.

Academic performance has traditionally referred to some method of expressing a student's scholastic standing. Usually this is a grade for a course, an average of courses in a subject area, or an average of all courses as expressed on some quantitative scale. The numerical value is given the name grade point average. Standardized achievement tests and other tests are also used, but the grade point average is most often used.

Since grades have an important role as an indicator of performance, it is essential to consider their weaknesses and strengths. Consider a relationship that is not strong. This might be caused by uncontrolled variations of grades. The variations may result when not all students take the same courses, teachers use different criteria in assigning marks, errors of judgement of teachers about the quality of achievement, and differences among students in motivation. In research on academic prediction, Lavin found that little effort has been devoted to controlling sources of variations.[3] Consequently, student grades lack a high degree of comparability and possibly should not be used as a single predictor. In contrast to this, in a study relating to academic

---

[3]David E. Lavin, <u>The Prediction of Academic Performance</u> (Hartford Connecticut: Connecticut Printers, Incorporated, 1965), p. 19.

prediction scales, Bloom and Peters reported that variations in grades are not as great as has been generally thought. Their findings illustrated a grade reliability of +.70, +.80, and some correlations as high as +.85.[4] In general, their research indicated that errors of estimates of grade prediction can be reduced and thereby academic prediction improved. An apparent strength of grade averages is their convenience of access and quantification. It is important, though, to remember that the influence of grades may not be the only factor which has affected the results of a certain study. A weak relationship might also have been caused by not having the right variables isolated or by measurement errors of the predictors. Studies in education are very complex and no way has been determined to completely separate selected independent and dependent variables from unwanted factors. Also, measurement techniques are not perfect. Rather, they give only an estimate of actual performance.

Another problem involved in measurement is brought about by grouping students according to their performance and ability. There are high and low achievers, and under and over achievers which are measured relative to their particular group without reference to the population as a whole. Relationship between ability and academic performance is well documented.[5] Since this relationship has been

---

[4]Benjamin S. Bloom, and Frank R. Peters, The Use of Academic Prediction Scales for Counseling and Selecting College Entrants (New York: The Free Press of Glencoes, Incorporated, 1961) p. 5.

[5]Lavin, op. cit., p. 22.

established, the emphasis is toward improvement of the actual prediction. This has induced consideration of nonintellectual factors. Unfortunately, this can lead to factors that are not independent of ability. This creates serious problems when interpreting findings that are biased because of data being obtained from various groups of students which perform relative to ability.

Failure to equate performance groups for ability may not be the only weakness. A third problem is that high and low achievement and over and under achievement also exists in several types. That is, they are not necessarily expressed as a unit. In reality they are probably quite complex and occur in various combinations and degrees.

A fourth problem is posed by measurement of performance which is at the extremes. This could produce data that, without the balance imposed by the average group, has a linear rather than a curvilinear relationship. Guilford in his book of educational statistics indicates that most relationships are linear, but care needs to be used when interpreting data so not to overlook the possibility of curvilinear relationships.[6]

In addition to problems in measurement, there are also difficulties which arise in the actual prediction of performance. Some result from the variables used for predictions, interpretation of the relationship of independent and dependent variables, and the design

---

[6] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, 1965), pp. 107-108.

of the study.

The variables used in a study cannot be completely separated and are influenced by some situational factors peculiar to the particular population. This leads to usage of predictive factors in various situations that are not necessarily the same as those in which the factors were obtained. In obverse to this, it also happens that different predictors are not independent of each other. Rather than prediction from a unit factor, the causal relationships probably are more complex and therefore a combination of several factors.

In interpreting relationships between the variables, it is possible to make incorrect assumptions of linearity. It has been documented previously that most relationships are linear but there still remains the possibility of curvilinear relationships. Relationships of extreme magnitudes may be misinterpreted and applied to unjustified populations. The establishment of causal relationships is necessary in order to understand why variables correlate high or low.

The study design must take into consideration such basic correlates as sex, ability, and socioeconomic status and whether or not a design is static or longitudinal. If these factors are not controlled, serious errors in predicting might occur.

Several problems of measuring academic performance have been explored. Some of the difficulties which arise in the actual prediction of performance have also been discussed. Most prediction research has been concerned primarily with intellectual and ability factors as predictors. The research and literature which pertains specifically to relationships of geometry achievement with physics and chemistry achievement was not enormous or necessarily significant as will be indicated in the next sections.

Literature on Relationships of Geometry and Physics Achievement

Much has been written on the importance of relating mathematics and physics. Several people have stated the necessity of combining the content and developing an applicable sequence between these two fields. Others have indicated predictive possibilities for physics from mathematics, especially as it relates to algebra and geometry. But in the literature there exist only a few studies of actual research relating mathematics and physics with correlations between grades and other factors.

Thorndike, while at Milton Academy, conducted a small scale study correlating mathematics and foreign language grades with physics grades. The foreign language grade for each student was the average of four years in the course. Involved with the grade was a correction in a downward direction for repetition of a course or for changing languages. The correlation coefficient was computed by the formula $r = \sum XY / \sqrt{\sum X^2 \sum Y^2}$ and the probable error by the formula P.E. $= +0.67(1 - r^2) / \sqrt{r}$. The correlation coefficient of mathematics and physics was 0.77 and of foreign language and physics 0.46. The mathematics grades were averages of three years instead of four and were also corrected for any cases of repetition. The difference in the number of years was made since prediction of the physics grade was wanted on the basis of three years of previous mathematics grades.[7]

Thorndike also investigated whether a student's grade in geometry would be more indicative than an average grade in all mathematics courses. He thought it possible that deductive reasoning so essential in geometry and physics might show up in a higher correlation. However, his correlation was not as good as for the general mathematics average, and he gave indication of the necessity of verifying the measures involved.[8]

Winegardner, at Piedmont High School, attempted to determine some relationship of success in algebra and geometry to success in physics for use in motivation and guidance. The data were based on the records of graduates from one high school. Final semester grades on a five point scale were recorded in algebra I, plane geometry, United States History, physics, and chemistry. Respective intelligence quotients were also recorded. The study was based on correlations between algebra and plane geometry with physics and chemistry, while using history as a means of comparison. The coefficients of correlations were derived by using the product moment method. The reliability of each of the coefficients of correlation were determined by finding the probable error.[9]

---

[7]Albert Thorndike, "Correlation Between Physics and Mathematics Grades," The Mathematics Teacher, 46:652, October, 1946.

[8]Ibid., pp. 652-653.

[9]J. H. Winegardner, "The Relation Between Secondary Mathematics and Physics and Chemistry," The Mathematics Teacher, 32:220-222, May, 1939.

The intelligence quotients were correlated with physics, chemistry, and history, and then weighted in order to be comparable to the grades. The findings indicated a positive relationship between grades in geometry with physics and chemistry. The correlation of geometry and chemistry was .6947 with a probable error (P.E.) of .022; of geometry and physics .6879 with a P.E. of .025. Comparison with other factors further indicated the close relationship between geometry and physics and chemistry. The correlation of geometry and history was .5621 with a P.E. of .025; of algebra and chemistry .5954 with a P.E. of .024; of algebra and physics .4878 with a P.E. of .035; of algebra and history .5502 with a P.E. of .023; of intelligence quotient (I.Q.) and chemistry .5806 with a P.E. of .026; of I.Q. and physics .4471 with a P.E. of .038; of I.Q. and history .5565 with a P.E. of .023; and of algebra and geometry .6658 with a P.E. of .019. When the probable errors were considered, the correlations of algebra grades and intelligence quotients were correspondingly close in value. Geometry appeared to best predict achievement in physics and chemistry, whereas algebra and intelligence quotients seemed to predict more general abilities. In spite of these findings it should be remembered that success in physics or chemistry might not result from good work in mathematics. This high correlation does not necessarily imply the cause.[10]

---

[10] Ibid.

Some studies have investigated prediction of physics achievement with factors other than grades. MacKinney and others identified three factors: general intelligence, male interest-achievement, and specific science achievement.[11] In contrast to Thorndike and Winegardner, they discovered that science course grades appear to contain a sizable component of invalid variance attributed to using grades as a means of discipline. Hence, more emphasis should be placed on the use of standardized achievement tests instead of grades for criterion purposes. These results were obtained by intercorrelations and factor analyses of sixteen aptitudes with science achievement variables from high school science.[12]

Powers and Witherspoon considered the American Council on Education (ACE) examination scores as a possible means of predicting success in general college physics. They selected the population from students at Arkansas State Teachers College. Data concerning ACE scores, physics grades, and general grade point averages (GPA) were then obtained. The correlations of ACE with physics were .38 and of GPA with physics .74.[13] This illustrates that the ACE scores were weak predictors whereas the GPA correlations were more significant.

---

[11]A. C. MacKinney and others, "Factor Analyses of High School Science Achievement Measures," The Journal of Educational Research, 54:173, January, 1961.

[12]Ibid., pp. 176-177.

[13]Glenn F. Powers and Paul Witherspoon, "ACE Scores as a Possible Means of Predicting Success in General College Physics Courses," Science Education, 47:416, October, 1963.

Carter investigated certain mathematical abilities in physics by using students from several high schools in Missouri. A subsidiary problem was concerned with the relations of success in physics as measured by intelligence and teachers' marks. The findings showed there existed a high correlation between reading ability and ability to recognize mathematical concepts in physics than between reading ability and computational ability. Correlations between performance in physics and ability to recognize mathematical concepts in physics were slightly higher than correlations between performance in physics and either intelligence, reading ability, or computational ability. With the exception of computational ability and variability of performance on some tests, the differences between males and females were not great enough to be considered very significant. The females were slightly higher in reading ability and in intelligence and the males some higher on the mathematics tests.[14]

Literature on Relationships of Geometry and Chemistry Achievement

Content similarities of chemistry and geometry or mathematics have not been expressed to the extent of physics and geometry or mathematics grades as a predictor of achievement in chemistry. However, Winegardner did find that there existed a higher correlation of geometry grades with chemistry grades (.6947) than of geometry grades with physics

---

[14] William Ray Carter, "A Study of Certain Mathematical Abilities in High School Physics," The Mathematics Teacher, 25:465-466, December, 1932.

grades (.6879). This was a better correlation than with any other subject, including algebra. Hence, the relation of success in geometry to success in chemistry was real and positive although again the high correlation does not permit one to assume a cause.[15]

Hanson, in a study for selection of students in an accelerated college chemistry class, found that high school chemistry is a valuable aid for success in college chemistry. He also stated linquistic factors and mathematical aptitude would probably contribute to success in high school chemistry to the same extent they do in college chemistry. Consequently, there was not too much gained by incorporating measures of these factors in a selection procedure.[16]

Homman and Anderson attempted to locate several factors and their relationship to achievement in high school chemistry by using factorial design and covariance. They showed no significant differences in chemistry achievement due to prior experience in science or mathematics.[17]

---

[15] Winegardner, loc. cit.

[16] Robert W. Hanson, "Selection of Students for Placement in Accelerated First Year College Chemistry," School Science and Mathematics, 64:790, December, 1964.

[17] Guy B. Homman and Kenneth E. Anderson, "A Study of Several Factors and Their Relationship to Achievement in High School Chemistry by Use of Factorial Design and Covariance," Science Education, 46:269-282, April, 1962.

Porter and Anderson investigated prediction of chemistry success by factors other than grades. These factors were intelligence, specific abilities, and achievement tests. Their findings indicated intellectually superior students achieved more in terms of a total chemistry test than either the average or lower group, and the average achieved more than the lower. Specific abilities as measured were not perfectly related to each other or to the measured intelligence. This research implied there were evidently other factors in addition to intelligence in operation in order to produce the particular results about relationships of the specific abilities and intelligence.[18]

Schelar and others at Northern Illinois University tried to find a satisfactory method of placing students in an elementary chemistry course designed primarily for chemistry majors. Preliminary results pointed to the Cooperative Mathematics Pretest for College Students, Form X, as the best criterion for placing freshman students. But an examination designed using skills commonly believed essential to success in beginning chemistry was a better predictor. The correlation between this examination and chemistry grades was .860 while between the mathematics tests and chemistry grades only .625.[19] This showed

---

[18]Majorie Ruth Porter and Kenneth E. Anderson, "A Study of the Relationship of Specific Abilities in Chemistry to Each Other and to Intelligence,"Science Education, 43:19, February, 1959.

[19]Virginia M. Schelar, Robert B. Cluff, and Bernice Roth, "Placement in General Education," Journal of Chemical Education, 40:369-370, July, 1963.

that improvement of a predictor was possible.

MacKinney's study of physics achievement also analysed the prediction of chemistry achievement. General intelligence, male interest-achievement, and specific science achievement were recognized to be better measures of chemistry success than were grade point averages.[20]

Carpenter's study indicated that those students who enrolled in chemistry with several years of general science and biology achieved better than those with only biology.[21] In contrast, Homman and Anderson showed no significant differences in chemistry achievement due to prior experience in science or mathematics.[22]

Interest and sex have also been factors investigated in studying achievement relationships. A study by Frandsen and Sessions reported results which supported that there was no significant relationship between interest and achievement.[23] In contrast, other authorities reported that students performed better in those subjects in which they were interested. Interest was interpreted to be closely related to career plans.[24]

---

[21] H. A. Carpenter, "Success in Physics and Chemistry in Relation to General Science and Biology," Science Education, 14:589-599, May, 1930.

[22] Homman and Anderson, loc. cit.

[23] Arden N. Frandsen and Alwyn D. Sessions, "Interests and School Achievement," Educational and Psychological Measurement, 13:94-101, March, 1953.

[24] T. Bentley Edwards and Alan B. Wilson, "The Association Between Interest and Achievement in High School Chemistry," Educational and Psychological Measurement, 19:601-610, Winter, 1959.

In regard to sex, Hanske determined superiority of boys over girls in high school chemistry achievement.[25] However, pretest knowledge was not held constant and the groups were matched to median intelligence rather than holding intelligence constant. Opposing the sex difference relationship in chemistry achievement, Anderson and others found that sex was not a factor nor did it influence the results of the method of instruction.[26]

Some research has been conducted on relationships of achievement in science, rather than specifically physics or chemistry, with such factors as intelligence, reading achievement, and interest. Barrilleaux found a high and very significant positive relationship between the relative intensity of science interest and the probability of success in high school science for intelligence quotient ranges of 86 through 139. With an intelligence quotient below 86 the relationship was still positive but low. Approximately 85 per cent of students with high science interest and intelligence quotients above 110 were successful.[27]

---

[25] Carl F. Hanske, "Sex Differences in High School Chemistry," The Journal of Educational Research, 23:412-416, May, 1931.

[26] Kenneth E. Anderson, Fred S. Montgomery, and Dale P. Scannell, "An Evaluation of the Introductory Chemistry Course on Film by Factorial Design and Covariance with Method and Sex as the Main Variables," Science Education, 45:269-274, April, 1961.

[27] Louis E. Barrilleaux, "High School Science Achievement as Related to Interest and I.Q.," Educational and Psychological Measurement, 21:929-936, Winter, 1961.

Scott analyzed the relationship between intelligence quotients and gain in reading achievement with arithmetic reasoning, social studies, and science. Findings indicated the following: wide variations in the amount of gain as measured by the achievement tests of similar intellectual status, inconsistency among individuals of the amount of gain for the various tests, intelligence and arithmetic reasoning correlated highest, intelligence and science correlated lowest, reading achievement correlated low with science, and a positive correlation between reading gain and gain in arithmetic reasoning and science.[28] These results implied that improved reading contributed to better performance in arithmetic and science but not to a great extent.

Limitations of Previous Studies

Some of the limitations and weaknesses of the previous studies have already been indicated. Much has been said concerning the relationship of science and mathematics with little research to support it. Some studies indicated geometry grades and other factors as predictors of success in physics and chemistry without properly analyzing their statistical measures of frequency distributions and measures of association. The mere grouping of data does not accomplish an analysis.

---

[28] Carrie M. Scott, "The Relationship Between Intelligence Quotients and Gain in Reading Achievement with Arithmetic Reasoning, Social Studies, and Science," The Journal of Educational Research, 56:322-326, February, 1963.

Rather, more measures of the degree of dispersion, variability, or non-homogeneity of the data needed to be made. In the measurement of association the form of the relation should be determined, variation about the form of relationship established, and then reduced to a relative basis. Only with this can the data be better interpreted.

More work was needed in prediction of physics and chemistry achievement by using multiple regression. Since fluctuations in a given arrangement of data were seldom dependent upon a single cause, the measurement of association between such a group of data and several of the variables causing these fluctuations would have improved the results.

Samples of particular populations were not adjusted for possible errors. The average of several measurements were taken as the true measurement disregarding the average being obtained from a sample. Consequently, it was subject to a sampling error which should have been computed. Some of the statistical calculations were misinterpreted as a result of sampling techniques. For example, widely used probable error was of comparatively little value. Extensive use of the probable error should not be used for it gives a value far beyond its worth as compared with the standard error.[29]

---

[29] Herbert Arkin and Raymond R. Colton, Statistical Methods (New York: Barnes and Nobel, Incorporated, 1962), p. 115.

Thus it seems that while a few studies have made rather definite and valuable conclusions concerning mathematical abilities in high school physics and chemistry, many questions have not been answered. In particular, relationships have not been sufficiently determined between chemistry and physics achievement with all factors of various common aptitude tests and measures. Further study should indicate the relative importance of grades and aptitude factors in the prediction of physics and chemistry achievement.

CHAPTER III

METHOD

The Research Design

The research was basically a correlational study. Various simple correlations were established by using grades and scores from the Differential Aptitude Test (DAT) as variables. Multiple correlations determined the relationship between success in physics and chemistry based on combinations of variables selected for the study. This led to a multiple regression equation which described the predictiveness of physics and chemistry achievement by using a combination of variables.

Sources and Kinds of Data Used

There were two different populations used for the study. These were selected from the 1965 senior class of the three high schools of the Topeka Public Schools, Topeka, Kansas. The high schools were Topeka West, Highland Park, and Topeka High. One population was determined by all students who had taken physics, geometry, and the DAT, called the physics population. The other population was determined by all students who had taken chemistry, geometry, and the DAT, called the chemistry population. There were 122 males and 22 females in the physics population. The breakdown of the physics population was 50 males and 8 females at Topeka West, 13 males and 2 females at

Highland Park, and 59 males and 12 females at Topeka High. This is summarized in Table I.

TABLE I

DISTRIBUTION OF PHYSICS POPULATION MALES AND FEMALES OF THE TOPEKA PUBLIC HIGH SCHOOLS

School	Males	Females	Total
Topeka West	50	8	58
Highland Park	13	2	15
Topeka High	59	12	71
Total	122	22	144

There were 143 males and 104 females in the chemistry population. Relative to the respective schools, Topeka West consisted of 63 males and 50 females, Highland Park had 15 males and 13 females, and Topeka High had 65 males and 41 females. This is summarized in Table II.

TABLE II

DISTRIBUTION OF CHEMISTRY POPULATION MALES AND FEMALES OF THE TOPEKA PUBLIC HIGH SCHOOLS

School	Males	Females	Total
Topeka West	63	50	113
Highland Park	15	13	28
Topeka High	65	41	106
Total	143	104	247

By taking students from all schools in the Topeka system, a workable balance of types of people and backgrounds was approximated. No distinction was made in regard to various economic influences or other environmental factors.

Geometry, physics, and chemistry grades were converted to point scores for the raw data of these three variables. The DAT has nine factors: verbal reasoning, numerical ability, abstract reasoning, space relations, mechanical reasoning, clerical speed and accuracy, spelling, sentences, and verbal reasoning plus numerical ability. The obtained scores for each of these categories constituted the raw data for the DAT variables.

Collection and Analysis of Data

All data were collected from the transcripts and cumulative folders of the population with the exception of some DAT scores obtained from the respective junior high schools. The data were entered on forms prepared for computer programmers and submitted to the Computer Center at Kansas State University, Manhattan, Kansas. The basic program used by the IBM 1410 computer was a multiple regression analysis.

Data were analysed for both populations and subsets of these groups. The subsets of the physics population were all males, all females, Topeka West, Highland Park, and Topeka High. The same grouping was made for the chemistry population. Therefore, a total of twelve different groups was studied.

The arithmetic means ($\bar{X}$) were calculated from $\bar{X}_i = \sum_{i=1}^{M} X_i / N$ and the variances (σ^2) by $\sigma^2_i = \sum_{i=1}^{M} X_i^2 / (N - 1)$, where M is the number of variables and N the number of observations. Throughout this discussion, the M and N will retain the same meaning. Arithmetic means gave the measure of central tendency of the particular scores and the variances indicated the scatter or dispersion about the means.

Simple correlation coefficients (r) were obtained for each independent variable with each dependent variable. The independent variables included the geometry grades and the nine factors of the DAT. The dependent variables included the physics grades and the chemistry grades. The formula used was $r_{ij} = \sum X_i X_j / \sqrt{\sum X_i^2 \sum X_j^2}$ where $i = 1, (M - 1)$ and $j = (i + 1), M$. The coefficient of correlation was used as the comparative measure of association.

The multiple regression equation was of the form $Y' = A + \sum_{i=1}^{M} b_i X_i$. The method of least squares was used to determine this equation. The line of regression indicated the form of the relationship.

Interpreting the form of relationship between the independent and dependent variables required several statistical methods. The standard error of estimate (S.E.) gave the measure of variation or dispersion about the regression equation. It was derived from the equation $S.E. = \sum d_i^2 / (N - M - 1)$ where $\sum d_i^2$ is the residual sum of squares.

The multiple correlation (R) indicated the measurement of association on a relative basis. The equation for this was

$R = \sqrt{\sum\hat{y}^2 / \sum y^2}$ where $\sum\hat{y}^2$ is the sum of squares due to regression. The coefficient of determination (R^2) measured the proportion of the variance in Y that is explained by X_i. R^2 was obtained from the multiple correlation so $R^2 = \sum\hat{y}^2 / \sum y^2$. An F ratio, (S. E.) $(\sum \hat{y}^2)$ / (M - 1), was used to test whether an observed R was significantly different from zero. These measures constituted the analysis of the multiple regression relationship between the independent and dependent variables.

Limits of the Study

The study did not have a random sampling of students from a total school population who were all required to take the geometry, physics, and chemistry courses. Instead, the population consisted of only those students who had previously taken all three courses on a non-required and pre-selective basis. Hence, there was not an equivalent number of above average, average, and below average geometry achievers enrolled in the physics and chemistry courses.

Highland Park had few students enrolled in the physics and chemistry classes from the two populations. This was due primarily to a lower student enrollment and the DAT criterion. One of the six junior high schools which sent students to Highland Park had not given the DAT.

The F test used in the multiple regression analysis did not meet all of the necessary assumptions of this statistical tool. The F test involves the following requirements: the sampling within sets should be random; the variances from within the various sets must be approximately equal; observations within experimentally homogeneous sets should be from normally distributed populations; and the contributions to total variance must be additive.[30] Consequently, the F ratios used in this study are to be evaluated relative to this limitation.

Finally, there were limitations due to the statistical method. The statistical technique used for the study was objective. This was an important aspect of the study, but probably not all human behavior can be understood by this basis alone. Pertinent subjective analyses needed to be employed to further understand the results. This information was not available. Hence, the results could not be affected by the necessary subjective interpretation.

---

[30] Guilford, op. cit., p. 274.

CHAPTER IV

FINDINGS

Physics Population

Physics hypothesis. The first hypothesis stated there would be a substantial positive correlation between geometry achievement and physics achievement. A comparison of the differences in the geometry and physics grades of the physics population indicated there would be a significant correlation. As represented in Table III, 36 students received the same geometry and physics grades, more than any other possible single combination.

The scatter about the grades correlating perfectly did not appear to be extreme. In addition to the same grades for the variables, 8 students received physics grades which were higher than the geometry grades and differed no more than 3 points on an 8-point scale. The 8-point scale was determined by taking the sum of both semesters' point scores issued for a particular course. The point score combinations for each semester were four points for an A, three points for a B, two points for a C, one point for a D, and zero points for an F. On the other side of the perfectly correlating grades, 100 students obtained a lower grade for physics which differed no more than 4 points with the corresponding geometry grade. Hence, in consideration of all possible combinations of grades, there appeared a strong tendency for grades in physics to be lower than those in geometry.

TABLE III

DIFFERENCES IN THE GEOMETRY AND PHYSICS GRADES FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

(x, x+a)	Tally	Total
(x, x+8)		0
(x, x+7)		0
(x, x+6)		0
(x, x+5)		0
(x, x+4)		0
(x, x+3)	1	1
(x, x+2)	11	2
(x, x+1)	11111	5
(x, x+0)	11111 11111 11111 11111 11111 11111 11111 1	36
(x, x-1)	11111 11111 11111 11111 11111 11111 11111	35
(x, x-2)	11111 11111 11111 11111 11111 11111 11	32
(x, x-3)	11111 11111 11111 11111 111	23
(x, x-4)	11111 11111	10
(x, x-5)		0
(x, x-6)		0
(x, x-7)		0
(x, x-8)		0
Total		144

NOTE: This table should be read as follows; The geometry grade x compared to a corresponding grade of x+a for physics; the total represents all corresponding grades that compared in the same way.

Simple correlations. The simple correlations were a more accurate comparative measure of association of geometry and physics grades than the frequency distribution. Correlations were established between all the independent variables with the dependent variable of the physics population. For convenience, clarity, and comparison, the three highest and the two lowest correlations were selected and analysed for presentation in this paper. Additional information on all variables involved in the study may be obtained from Appendix A.

Table IV shows that the highest correlation obtained was with the geometry grade. This correlation was .68. The verbal plus numerical (V + N) factor of the DAT was also significant, correlating with the physics grade .67. The numerical factor correlation was .65. In contrast, the lowest correlation was .23 with the mechanical factor and the physics grade. The male correlation of .70 was substantially higher than the female correlation of .52 for geometry grades. This might have been attributed to the number of people from each sex in this particular population. There were a total of 122 males but only 22 females.

Means and variances. The average values or arithmetic means of selected variables from the physics population are represented in Table V. These indicated the typical geometry grade to be 6.09. This was higher than the average physics grade of 4.73, which corresponds to the trend suggested in the frequency distribution of Table III, page 27. In spite of this, the variance from Table VI for physics grades of 3.54 was higher than the variance of 2.64 for geometry grades. The difference

TABLE IV

SIMPLE CORRELATIONS OF GEOMETRY GRADES AND SELECTED DAT FACTORS WITH PHYSICS GRADES FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Geometry	.68	.70	.52	.73	.81	.65
V + N	.67	.69	.58	.77	.54	.62
Numerical	.65	.66	.64	.71	.52	.64
Clerical	.31	.36	-.11	.34	.43	.30
Mechanical	.23	.35	.29	.31	-.26	.25

TABLE V

MEANS OF PHYSICS GRADES, GEOMETRY GRADES, AND SELECTED FACTORS OF THE DAT FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Physics	4.73	4.61	5.55	5.10	4.40	4.49
Geometry	6.09	5.93	7.05	6.07	5.53	6.23
V + N	53.45	53.13	56.32	54.47	47.73	53.83
Numerical	26.04	25.83	27.64	26.41	23.13	26.35
Clerical	55.97	54.32	65.00	55.81	53.67	56.62
Mechanical	41.96	43.89	31.45	42.83	41.73	41.30

TABLE VI

VARIANCES OF PHYSICS GRADES, GEOMETRY GRADES, AND SELECTED FACTORS OF THE DAT FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Physics	3.54	3.55	3.21	3.57	3.69	3.40
Geometry	2.64	2.57	2.14	2.94	3.55	2.21
V + N	207.87	231.92	85.37	240.32	125.50	195.86
Numerical	57.45	62.31	30.15	68.28	40.55	51.63
Clerical	133.29	100.37	225.43	98.09	64.67	177.90
Mechanical	117.93	100.47	84.16	106.15	120.21	129.35

in variance indicated more scatter about the physics average than the geometry average.

The male physics average of 4.61 was lower than the female average of 5.55. Their respective variances were 3.55 and 3.21, which is a close dispersion. The male geometry mean of 5.93 was also lower than the 7.05 average for females. The corresponding variances were 2.57 and 2.14. The difference in the number of males and females again must be considered when interpreting these results.

Multiple regression analysis. Multiple correlations were established between two independent variables and the dependent variable (physics). This correlation indicated the measurement of association for the variables on a relative basis. The multiple correlations were related to the intercorrelations among the independent variables as well as to their correlations with the dependent variable.

Table VII shows the highest multiple correlation (R) was .77, with the geometry and V + N variables. The R for geometry and numerical of .76 was quite close to the highest obtained value. In comparison, the mechanical and clerical R of .39 was much lower.

TABLE VII

MULTIPLE CORRELATIONS INVOLVING COMBINATIONS OF TWO SELECTED VARIABLES WITH PHYSICS GRADES FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry and V + N	.77	.78	.67	.84	.81	.73
Geometry and Numerical	.76	.77	.65	.80	.81	.75
Numerical and V + N	.68	.70	.66	.77	.56	.65
Mechanical and Clerical	.39	.45	.29	.47	.53	.40

In order to interpret R, the coefficient of multiple determination (R^2) found in Table VIII was used. The R^2 portrayed the proportion of variance in the dependent variable (Y' or physics) that is dependent upon, associated with, or predicted by the independent variables (X_1 and X_2).

The geometry and V + N variables accounted for 59 per cent of the variance in physics compared to 57 per cent with the geometry and

TABLE VIII

COEFFICIENTS OF DETERMINATION INVOLVING COMBINATIONS OF TWO SELECTED VARIABLES WITH PHYSICS GRADES FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry and V + N	.59	.61	.45	.70	.65	.54
Geometry and Numerical	.57	.60	.42	.65	.65	.56
Numerical and V + N	.47	.49	.43	.59	.31	.42
Mechanical and Clerical	.15	.21	.08	.22	.28	.16

numerical variables. The per cent of variance represented by the mechanical and clerical factors was a very low 15. Hence, a very significant R was obtained for only some of the variables.

Lines of regression described the form of relationship for the independent variables. The regression equation for the best combination of two independent variables, illustrated in Table IX, was $Y' = -1.36 + .52X_1 + .05X_2$, where X_1 and X_2 represented respectively the geometry and V + N variables. Another good relationship for prediction of physics achievement was $Y' = -1.10 + .54X_1 + .10X_2$, where X_1 and X_2 are correspondingly the geometry and numerical variables. The poorest relationship was with the mechanical and clerical factors. The form of this regression line was $Y' = .06 + .04X_1 + .05X_2$, where the independent variables are mechanical (X_1) and clerical (X_2).

Since the relationship was not perfect between physics and the independent variables, the actual values did not coincide with the theoretical values. This meant the existence of a scattering or variation of this sort was measured by the standard error of estimate (S.E.). The variations were allowed for, and a range established within which a given proportion of values would fall.

The geometry and V + N regression line had the smallest S.E., which was 1.21, as indicated in Table IX. Consequently, one S.E. of 1.21 included 68 per cent of the cases when measured positively and negatively about the line of regression. Three S.E.'s contained 99.7 per cent of the cases. In comparison, the S.E. for the poorest form of relationship, mechanical and clerical, was 1.74.

The F ratio in Table IX of 101.27 for the geometry and V + N variables showed that a significant multiple correlation existed. It must be remembered, however, that not all the assumptions of the F ratio were met by the population. Contrasting this score, the F ratio of the mechanical and clerical factors was 12.88. The best form of relationship for males was $Y' = -1.32 + .52X_1 + .05X_2$, where X_1 and X_2 are respectively the geometry and V + N variables. For the females, the most significant equation was $Y' = -2.01 + .17X_1 + .07X_2$, where X_1 and X_2 are respectively the numerical and sentence factors.

A regression equation for the ten independent variables was also formulated. This was $Y' = -1.50 + .45X_1 - .01X_2 + .04X_3 + .00X_4 + .00X_5 + .00X_6 + .00X_7 - .00X_8 + .02X_9 + .03X_{10}$. The variables in the

TABLE IX

SELECTED MULTIPLE REGRESSION EQUATIONS, F RATIOS, AND STANDARD ERRORS OF ESTIMATE FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables		Total Population				
X_1	X_2	B_1	B_2	A	F	S.E.
Geometry	V + N	.52	.05	-1.36	101.27	1.21
Geometry	Numerical	.54	.10	-1.10	95.21	1.24
Numerical	V + N	.06	.06	-.03	61.59	1.38
Mechanical	Clerical	.06	.05	.06	12.88	1.74

NOTE: This table should be read as follows: The two independent variables (X_1 and X_2) predict the dependent variable physics (Y') in the form $Y' = A + B_1X_1 + B_2X_2$; this form of relationship is interpreted by the F ratio and S.E.

equation ($X_1, X_2, \ldots, X_{10}$) are in the following order: geometry, verbal, numerical, abstract, space, mechanical, clerical, spelling, sentences, and V + N. The zero coefficients of the independent variables suggested that the maximum number of factors usable in a predictive instrument would probably be four or five. The geometry, verbal, numerical, sentences, and V + N appeared to be the most significant variables. The R was .78, the R^2 was .61, and the F ratio was 20.94. It was interesting that the F ratio of 20.94 for the ten independent variables was close to the lowest F ratio of 12.88 for the mechanical and clerical factors.

All findings taken together indicated a substantial positive correlation between geometry achievement and physics achievement. The best predictive instrument obtained to estimate success in physics was an equation involving the geometry grade and the general intelligence factor (V + N) of the DAT.

Chemistry Population

Chemistry hypothesis. The second hypothesis stated there would be a substantial positive correlation between geometry achievement and chemistry achievement. A comparison of the differences in the geometry and chemistry grades of the chemistry population indicated there would be a significant correlation. As represented in Table X, 75 students received the same geometry and chemistry grades, more than any other possible single combination. The scatter about the grades correlating perfectly did not appear to be extreme. In addition to the same grades for the variables, 65 students received chemistry grades which were higher than the geometry grades and differed no more than 4 points on an 8-point scale. The 8-point scale was determined by taking the sum of both semesters' point scores issued for a particular course. The point score combinations for each semester were four points for an A, three points for a B, two points for a C, one point for a D, and zero points for an F. On the other side of the perfectly correlating grades, 107 students obtained a lower grade for chemistry which differed no more than 4 points with the corresponding geometry grade. Hence, in consideration of all possible combinations of grades, there was only a slight tendency for grades in chemistry to be lower than those in geometry.

TABLE X

DIFFERENCES IN THE GEOMETRY AND CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

(x, x+a)	Tally	Total
(x, x+8)		0
(x, x+7)		0
(x, x+6)		0
(x, x+5)		0
(x, x+4)	11	2
(x, x+3)	11111	5
(x, x+2)	11111 11111 11111 11111 1111	24
(x, x+1)	11111 11111 11111 11111 11111 11111 1111	34
(x, x+0)	11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11111	75
(x, x-1)	11111 11111 11111 11111 11111 11111 11111 11111 11111 11111 11	52
(x, x-2)	11111 11111 11111 11111 11111 11111 11111 11111	40
(x, x-3)	11111 11111	10
(x, x-4)	11111	5
(x, x-5)		0
(x, x-6)		0
(x, x-7)		0
(x, x-8)		0
Total		247

NOTE: This table should be read as follows: The geometry grade x compared to a corresponding grade of x+a for chemistry; the total represents all corresponding grades that compared in the same way.

Simple correlations. The simple correlations were a more accurate comparative measure of association of geometry and chemistry grades than the frequency distribution. Correlations were established between all the independent variables with the dependent variable of the chemistry population. For convenience, clarity, and comparison, the three highest and the two lowest correlations were selected and analysed for presentation in this paper. Additional information on all variables involved in the study may be obtained from Appendix B.

Table XI shows the highest correlation obtained was with the geometry grade. This correlation was .61. The verbal plus numerical (V + N) factor of the DAT was also significant, correlating with the chemistry grade .50. The sentences factor correlation was .48. In contrast, the lowest correlation was .16 with the mechanical factor and the chemistry grade. The male correlation of .61 was about the same as the female correlation of .60 for geometry grades. Highland Park's geometry correlation of .77 was relatively quite high. It must be remembered when interpreting this measure that there were only 28 of the 247 students from Highland Park.

Means and variances. The average values or arithmetic means of selected variables from the chemistry population are represented in Table XII. These indicated the typical geometry grade to be 5.77. This was higher than the average chemistry grade of 5.49. In spite of this, the variance, from Table XIII, for chemistry grades of 3.15 was higher than the variance of 2.71 for geometry grades. The difference

TABLE XI

SIMPLE CORRELATIONS OF GEOMETRY GRADES AND SELECTED DAT FACTORS WITH CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Geometry	.61	.61	.60	.52	.77	.62
V + N	.50	.50	.53	.50	.51	.46
Sentences	.48	.44	.53	.47	.53	.44
Clerical	.24	.21	.27	.18	.25	.32
Mechanical	.16	.18	.27	.14	.15	.14

TABLE XII

MEANS OF CHEMISTRY GRADES, GEOMETRY GRADES, AND SELECTED FACTORS OF THE DAT FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Chemistry	5.49	5.42	5.60	5.73	4.07	5.61
Geometry	5.77	5.76	5.80	5.84	5.00	5.91
V + N	51.14	52.45	49.34	52.33	44.32	51.67
Sentences	34.77	32.52	37.86	36.42	30.29	34.18
Clerical	56.95	54.16	60.78	57.49	56.93	56.38
Mechanical	37.39	42.61	30.22	38.49	34.71	36.93

TABLE XIII

VARIANCES OF THE CHEMISTRY GRADES, GEOMETRY GRADES, AND SELECTED FACTORS OF THE DAT FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Male	Female	Topeka West	Highland Park	Topeka High
Chemistry	3.15	3.29	2.96	2.79	2.96	3.02
Geometry	2.71	2.71	2.75	2.60	3.33	2.54
V + N	191.98	190.32	190.48	202.58	160.52	178.22
Sentences	176.31	154.58	191.33	169.16	165.92	181.31
Clerical	115.63	105.39	105.26	107.70	147.77	117.38
Mechanical	138.24	106.24	94.00	125.63	149.32	148.06

in variance indicated more scatter about the chemistry average than the geometry average.

The male chemistry average of 5.42 was lower than the female average of 5.60. Their respective variances were 3.29 and 2.96 which indicated a relatively close dispersion. The male geometry mean of 5.76 was nearly the same as the 5.80 average for females. The corresponding variances were 2.71 and 2.75.

Multiple regression analysis. Multiple correlations were established between two independent variables and the dependent variable (chemistry). This correlation indicated the measurement of association for the variables on a relative basis. The multiple correlations were related to the intercorrelations among the independent variables as well as to their correlations with the dependent variables.

Table XIV shows the highest multiple correlation (R) was .65 with the geometry and sentences variables. The R for geometry and V + N of .64 was quite close to the highest obtained value. In comparison, the mechanical and clerical R of .31 was much lower.

TABLE XIV

MULTIPLE CORRELATIONS INVOLVING COMBINATIONS OF TWO SELECTED VARIABLES WITH CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry and V + N	.64	.65	.63	.58	.77	.64
Geometry and Sentences	.65	.64	.66	.58	.79	.65
Sentences and V + N	.54	.53	.57	.54	.56	.50
Mechanical and Clerical	.31	.27	.41	.26	.33	.36

In order to interpret R, the coefficient of multiple determination (R^2) from Table XV was used. The R^2 portrayed the proportion of variance in the independent variable (Y' or chemistry) that is dependent upon, associated with, or predicted by the independent variables (X_1 and X_2).

The geometry and sentences variables accounted for 42 per cent of the variance in physics compared to 41 per cent with the geometry and V + N variables. The per cent of variance represented by the mechanical and clerical factors was a very low 10. Hence, a

TABLE XV

COEFFICIENTS OF DETERMINATION INVOLVING COMBINATIONS OF TWO SELECTED VARIABLES WITH CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry and V + N	.41	.42	.40	.33	.59	.41
Geometry and Sentences	.42	.41	.43	.34	.62	.42
Sentences and V + N	.29	.28	.32	.29	.31	.25
Mechanical and Clerical	.10	.27	.16	.07	.11	.13

significant R was obtained for only some of the variables.

Lines of regression described the form of relationship for the independent and dependent variables. The regression equation for the best combination of two independent variables, illustrated in Table XVI, was $Y' = 1.27 + .53X_1 + .03X_2$, where X_1 and X_2 represented respectively the geometry and sentences variables. Another good relationship for prediction of chemistry achievement was $Y' = 1.00 + .51X_1 + .03X_2$, where X_1 and X_2 are correspondingly the geometry and V + N variables. The poorest relationship was with the mechanical and clerical factors. The form of this regression line was $Y' = 1.80 + .03X_1 + .05X_2$, where the independent variables are mechanical (X_1) and clerical (X_2).

Since the relationship was not perfect between chemistry and the independent variables, the actual values did not coincide with the theoretical values. This meant the existence of a scattering or variation

TABLE XVI

SELECTED MULTIPLE REGRESSION EQUATIONS, F RATIOS, AND STANDARD ERRORS OF ESTIMATE FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables		Total Population				
X_1	X_2	B_1	B_2	A	F	S.E.
Geometry	V + N	.51	.03	1.00	83.82	1.37
Geometry	Sentences	.53	.03	1.27	87.84	1.36
Sentences	V + N	.03	.04	2.07	51.03	1.50
Mechanical	Clerical	.03	.05	1.80	13.13	1.69

NOTE: This table should be read as follows: The two independent variables (X_1 and X_2) predict the dependent variable chemistry (Y') in the form $Y' = A + B_1X_1 + B_2X_2$; this form of relationship is interpreted by the F ratio and S.E.

about the regression line. A variation of this sort was measured by the standard error of estimate (S.E.). The variations were allowed for, and a range established within which a given proportion of values would fall.

The geometry and sentences regression line had the smallest S.E., which was 1.36 as indicated in Table XVI. Consequently, one S.E. of 1.36 included 68 per cent of the cases when measured positively and negatively about the line of regression. Three S.E.'s contained 99.7 per cent of the cases.

The F ratio in Table XVI of 87.84 for the geometry and sentences variables showed a significant multiple correlation existed.

Contrasting this score, the F ratio of mechanical and clerical factors was 13.13. In interpreting these F ratios, it is essential to note that not all of the statistical assumptions were satisfied.

The best form of relationship for males was $Y' = .61 + .53X_1 + .07X_2$, where X_1 and X_2 are respectively the geometry and numerical variables. For the females, the most significant equation was $Y' = 1.43 + .47X_1 + .04X_2$, where X_1 and X_2 represented, in order, the geometry and sentences variables.

A regression equation for the ten independent variables was also formulated. This was $Y' = .42 + .47X_1 - .02X_2 + .01X_3 + .01X_4 + .00X_5 - .01X_6 + .01X_7 - .00X_8 + .02X_9 + .03X_{10}$. The variables in the equation (X_1, X_2, ..., X_{10}) are in the following order: geometry, verbal, numerical, abstract, space, mechanical, clerical, spelling, sentences, and V + N. The zero coefficients of the independent variables suggested that the maximum number of factors usable in a predictive instrument would probably be four or five. The geometry, verbal, numerical, sentences, and V + N appeared to be the most significant variables. The R was .66, the R^2 was .44, and F ratio was 18.50. It was interesting that the F ratio of 18.50 for the ten independent variables was close to the lowest F ratio of 13.13 for the mechanical and clerical factors.

All findings taken together indicated a substantial positive correlation between geometry achievement and chemistry achievement. The best predictive instrument obtained was an equation involving the geometry grade and the sentences factor of the DAT.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

It was the purpose of this study to determine whether a geometry grade was a good predictor of achievement in physics and chemistry in the Topeka Public High Schools, Topeka, Kansas. The research was basically a correlational design. Correlations were established by using grades and scores from the Differential Aptitude Test (DAT) as variables. Eventually, multiple regression equations were determined as instruments to predict physics achievement and chemistry achievement by using a combination of variables.

There were two different populations used. These were selected from the 1965 senior class of the three Topeka Public High Schools. One group, called the physics population, was determined by all students who had taken physics, geometry, and the DAT. The other group, called the chemistry population, was determined by all students who had taken chemistry, geometry, and the DAT. The physics population consisted of 122 males and 22 females. The chemistry population had 143 males and 104 females.

The data were collected from the student records. The data were computed at the Computer Center at Kansas State University, Manhattan, Kansas. The basic program for the IBM 1410 computer was a multiple regression analysis.

Both populations consisted of only those students who had previously taken all three courses on a non-required and pre-selective basis. Hence, there was not an equivalent number of above average, average, and below average geometry achievers enrolled in the physics and chemistry courses.

It was found that there was a substantial positive correlation (.68) between geometry achievement and physics achievement. A higher multiple correlation (.77) was obtained by using the geometry grade and the verbal plus numerical (V + N) factor of the DAT. This led to development of a regression equation involving these two independent variables. The equation was $Y' = -1.36 + .52X_1 + .05X_2$, where X_1 and X_2 represented respectively the geometry and V + N variables.

The second part of the study, involving the chemistry population, indicated there was a substantial positive correlation (.61) between geometry achievement and chemistry achievement. A slightly higher multiple correlation (.65) was obtained with the geometry grade and the sentences factor of the DAT. This led to the regression equation $Y' = 1.27 + .53X_1 + .03X_2$, where X_1 and X_2 are respectively the geometry and sentences variables.

<u>Conclusions</u>

There was some justification for students entering the physics and chemistry classes to have previously received a good grade in geometry. Geometry grades, as the highest correlating factor with both physics and chemistry, verified this assumption. However, this does not indicate that the geometry grade is the best way to predict physics and chemistry achievement. A combination of geometry grades and a factor from the DAT expressed as a multiple correlation improved the correlation with the physics grade from .68 to .77. A similar combination for the chemistry grade improved the correlation from .61 to .65. Very possibly other factors not considered in this study would permit an even better prediction of physics and chemistry grades.

The degree of association, as expressed on a relative basis by the coefficients of correlation, was affected by the type of groups used in the populations. The populations were homogeneous groups in terms of intelligence scores and geometry grades. Since this meant there existed a lack of variability of these factors, the obtained correlations were probably lower than they would have been with heterogeneous groups of students.

A relationship seemed to exist between geometry and physics that was not present with geometry and chemistry. The correlations with the physics variable were consistently higher than those with the chemistry variable. When considering this possibility, it must be remembered that the physics and chemistry populations were different.

In both the physics and chemistry groups, the males and females performed at about the same level. If sex differences influence achievement results, it cannot be justified by this particular study.

Implications

This study indicated that if a student achieved good grades in geometry, then the physics and chemistry achievement would probably be acceptable. Thus the geometry grade is an efficient and justifiable method of regulating enrollment in the physics and chemistry classes. This permits selection of students capable of doing the required work, and those receiving a C average or above in geometry should therefore be allowed to enroll in the physics and chemistry courses.

In addition, the multiple regression equations have a very important role in the proper placement of students. Those who are below the geometry grade specification of a C average should not necessarily be directed away from the physics and chemistry courses. It is possible that the V + N or sentences factors of the DAT would be sufficiently high to balance the deficient geometry grade. The regression equations could be used to determine if this requirement was reached.

The correct selection of students for particular classes is quite important. One does not want to deny the opportunity for students to take physics and chemistry only on the basis of a geometry grade. Consequently, the evaluation of a student's DAT scores, by using the regression equations determined in this study, could further justify the acceptance or rejection of a student for admission into the physics or chemistry course.

BIBLIOGRAPHY

BIBLIOGRAPHY

BOOKS

Arkin, Herbert and Raymond R. Colton. Statistical Methods. New York: Barnes and Noble, Incorporated, 1962.

Arnold, Magda B. Story Sequence Analysis. New York: Columbia University Press, 1962.

Baggaley, Andrew R. Intermediate Correlational Methods. New York: John Wiley and Sons, Incorporated, 1964.

Berdie, Ralph F., and others. Who Goes to College? Minneapolis: University of Minnesota Press, 1962.

Bloom, Benjamin S., and Frank R. Peters. The Use of Academic Prediction Scales for Counseling and Selecting College Entrants. New York: The Free Press of Glencoe, Incorporated, 1961.

Borg, Walter R. Education Research An Introduction. New York: David McKay Company, Incorporated, 1963.

Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill Book Company, 1966.

Guilford, J. P. Fundamental Statistics in Psychology and Education. New York: McGraw-Hill Book Company, 1965.

Haggard, Ernest A. Intraclass Correlation and the Analysis of Variance. New York: The Dryden Press Incorporated, 1958.

Lavin, David E. The Prediction of Academic Performance. Hartford Connecticut: Connecticut Printers, Incorporated, 1965.

Mathieu, Philippa L., and others. Relationship of Group Counseling to Subsequent Academic Performance at the College Level. Cooperative Research Project, Wisconsin Psychiatric Institute, University of Wisconsin, Madison, Wisconsin, 1962.

Schill, William John. Career Patterns of Technical and Vocational Educators. Danville, Illinois: The Interstate Printers and Publishers, Incorporated, 1963.

Stuit, Dewey B., and others. Predicting Success in Professional Schools. Menasha, Wisconsin: George Banta Publishing Company, 1949.

Travers, Robert M. W. Educational Measurement. New York: The MacMillian Company, 1955.

Tucker, Ledyard R. Formal Models for a Central Prediction System. Richmond, Virginia: The William Byrd Press, Incorporated, 1963.

Watley, Donivan J., and Forrest L. Vance. Clinical Versus Actuarial Prediction of College Achievement and Leadership Activity. Cooperative Research Project, University of Minnesota, Minneapolis, Minnesota.

PERIODICALS

Anderson, Kenneth E., Fred S. Montgomery, and Dale P. Scannell. "An Evaluation of the Introductory Chemistry Course on Film by Factorial Design and Covariance with Method and Sex as the Main Variables," Science Education, 45:269-274, April, 1961.

Barrilleaux, Louis E. "High School Science Achievement as Related to Interest and I.Q.," Educational and Psychological Measurement, 21:929-936, Winter, 1961.

Bennet Jr., Clifford. "Problem Solving with Mathematics in Science," Science Education, 49:270-271, April, 1965.

Cain, Ralph W., and Eugene C. Lee. "An Analysis of the Relationship Between Science and Mathematics at the Secondary School Level," School Science and Mathematics, 63:705-713, December, 1963.

Capoferi, Alfred. "How Can a Junior High School Mathematics Teacher Strengthen the Science Course," School Science and Mathematics, 56:233-236, March 1956.

Carpenter, H. A. "Success in Physics and Chemistry in Relation to General Science and Biology," Science Education, 14:589-599, May, 1930.

Carpenter, Robert E. "How Much Mathematics Should be Required and Used in High School Physics," School Science and Mathematics, 62:374-378, May 1962.

Carter, William Ray. "A Study of Certain Mathematical Abilities in High School Physics," The Mathematics Teacher, 25:313-331, 388-419, 451-469, 1932.

Chansky, Norman M. "A Note on the Grade Point Average in Research," Educational and Psychological Measurement, 24:95-99, Spring, 1964.

Dessart, Donald J. "Mathematics in the Secondary School," Review of Educational Research, 34:298-312, June, 1964.

Edminston, R. W., and Betty Jane Rhoades. "Predicting Achievement," The Journal of Educational Research, 52:177-180, January, 1959.

Edwards, T. Bentley, and Alan B. Wilson, "The Association Between Interest and Achievement in High School Chemistry," Educational and Psychological Measurement, 19:601-610, Winter, 1959.

Estes, Ronald V. "A Review of Research Dealing with Current Issues in Mathematics Education," School Science and Mathematics, 61:623-630, November, 1961.

Frandsen, Arden N. "Appraisal of Interests in Guidance, "The Journal of Educational Research, 39:1-12, September, 1945.

Frandsen, Arden N., and Alwyn D. Sessions, "Interests and School Achievement," Educational and Psychological Measurement, 13:94-101, March, 1953.

French, John W. "Comparative Prediction of High School Grades by Pure-Factor Aptitude, Information, and Personality Measures," Educational and Psychological Measurement, 24:321-329, Summer, 1964.

Giusti, Joseph Paul. "High School Average as a Predictor of College Success: A Survey of the Literature," College and University, 39:200-209, Winter, 1964.

Groteluschen, Ruth. "Ways in Which the Science Teacher Can Help Strengthen Mathematics Instruction," School Science and Mathematics, 56:286-290, April, 1956.

Halliwell, Joseph W. "Dangers Inherent in Correlating Averages," The Journal of Educational Research, 55:327-329, April, 1962.

Hannon, Herbert. "An Analysis of the Mathematical Concepts Necessary for the College Physical Science Course," Science Education, February, 1959.

Hanske, Carl F. "Sex Differences in High School Chemistry," The Journal of Educational Research, 23:412-416, May, 1931.

Hanson, Robert W. "Selection of Students for Placement in Accelerated First-Year College Chemistry," School Science and Mathematics, 64:786-791, December, 1964.

Hills, John R. "Factor-Analyzed Abilities and Success in College Mathematics," Educational and Psychological Measurement, 17:615-622, Winter, 1957.

Hipsher, Warren L. "Study of High School Physics Achievement," The Science Teacher, 28:36-37, October, 1961.

Homman, Guy B., and Kenneth E. Anderson. "A Study of Several Factors and Their Relationship to Achievement in High School Chemistry by Use of Factorial Design and Covariance," Science Education, 46:269-282, April, 1962.

Klausmeier, Herbert J., and William Wiersma. "Effects of Condensing Content in Mathematics and Science in the Junior and Senior High School," School Science and Mathematics, 64:4-11, January, 1964.

Laper, Lois M. "How to Improve Science Teaching Through Mathematics," School Science and Mathematics, 61:487-488, October, 1961.

Mackinney, A. C., and others. "Factor Analyses of High School Science Achievement Measures," The Journal of Educational Research, 54: 173-177, January, 1961.

Michael, William B., and others. "High School Record and College Board Scores as Predictors of Success in a Liberal Arts Program During the Freshman Year of College," Educational and Psychological Measurement, 22:399-400, Summer, 1962.

Pack, Elmo. "Mathematics and Science," The Clearing House, 33:13-14, September, 1958.

Payne, William H. "Integrated Learning as a Result of Exercise in Mathematics and Science," School Science and Mathematics, 57:37-40, January, 1957.

Porter, Marjorie Ruth, and Kenneth E. Anderson. "A Study of the Relationships of Specific Abilities in Chemistry to Each Other and to Intelligence," Science Education, 43:12-19, February, 1959.

Powers, Glenn F., and Paul Witherspoon. "ACE Scores as a Possible Means of Predicting Success in General College Physics Courses," Science Education, 47:416, October, 1963.

Rasmussen, Del. "SAM - A Correlated Sequence in Science and Mathematics," The Science Teacher, 31:36-38, April, 1964.

Rettaliata, J. T. "Mathematics and Science: Partners in Progress," School Science and Mathematics, 64:173-179, March, 1964.

Richards, James M. Jr., and Calvin W. Taylor. "Predicting Academic Achievement in a College of Medicine from Grades, Test Scores, Interviews, and Ratings," Educational and Psychological Measurement, 21:987-994, Winter, 1961.

Schelar, Virginia M., Robert B. Cluff, and Bernice Roth. "Placement in General Education," Journal of Chemical Education, 40:369-370, July, 1963.

Scott, Carrie M. "The Relationship Between Intelligence Quotients and Gain in Reading Achievement with Arithmetic Reasoning, Social Studies, and Science," The Journal of Educational Research, 56:322-326, February, 1963.

Smith, Malcolm. "Integrated Mathematics and Physics," The Mathematics Teacher, 48:55-57, December, 1955.

Stroup, Francis. "The Grade - Point Average is Obsolete," The Journal of Higher Education, 34:10-15, January, 1963.

Teaf, Howard M. Jr. "Grades: Their Dominion is Challenged," The Journal of Higher Education, 35:87-88, February, 1964.

Thorndike, Albert. "Correlation Between Physics and Mathematics Grades," The Mathematics Teacher, 46:650-653, October, 1946.

Thorndike, Edward L. "Early Interests: Their Permanence and Relation to Abilities," School and Society, 5:178-179, 1917.

Winegardner, J. H. "The Relation Between Secondary Mathematics and Physics and Chemistry," The Mathematics Teacher, 32:220-222, May, 1939.

Yager, Robert E. "Grade Placement of High School Chemistry," The Science Teacher, 29:27-29, April, 1962.

APPENDIXES

APPENDIX A

DATA AND RESULTS OF THE PHYSICS POPULATION

A List of Abbreviated Titles

NOTE: The variables in Tables XVII, XXI, and XXII are denoted by numbers; the physics grade is 1, geometry grade - 2, verbal reasoning - 3, numerical ability - 4, abstract reasoning - 5, space relations - 6, mechanical reasoning - 7, clerical speed and accuracy - 8, spelling - 9, sentences - 10, and verbal reasoning plus numerical ability (V + N) - 11.

TABLE XVII

GEOMETRY GRADES AND DAT RAW DATA FOR THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

NOTE: In the sex column, males are 1 and females are 2; in the school column, Topeka West is 1, Highland Park is 2, and Topeka High is 3.

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
8	8	42	35	41	80	49	49	57	61	77	1	1	1
7	8	32	26	25	47	31	75	77	43	58	2	1	2
4	5	25	31	27	27	46	60	62	26	56	1	1	3
5	6	42	33	46	76	45	43	77	45	75	1	1	4
6	6	22	20	34	87	53	53	20	29	42	1	1	5
7	8	19	31	29	68	41	56	27	31	50	1	1	6
3	4	21	10	44	67	55	45	55	67	31	1	1	7
6	6	30	27	35	83	52	69	11	24	57	1	1	8
4	6	19	29	46	85	54	56	27	24	48	1	1	9
8	8	38	36	36	76	57	50	54	35	74	1	1	10
8	8	37	35	40	71	31	44	78	67	72	2	1	11
3	3	21	11	33	10	49	52	10	17	32	1	1	12
3	5	20	20	29	57	37	64	19	29	40	1	1	13
4	7	21	28	34	78	35	50	22	14	49	2	1	14
3	6	24	20	44	76	52	50	84	31	44	1	1	15
6	8	39	38	39	76	53	69	46	50	77	1	1	16
5	6	27	21	26	58	51	34	27	18	48	1	1	17
8	8	41	36	43	83	41	68	95	59	77	1	1	18
4	6	15	8	28	46	26	52	26	20	23	1	1	19
4	6	28	31	43	68	51	51	63	38	59	1	1	20
6	6	32	36	36	25	32	51	76	39	68	1	1	21
8	8	41	32	41	73	47	75	62	40	73	1	1	22
8	6	30	32	35	47	41	71	52	30	62	1	1	23
2	2	17	20	39	59	32	59	23	20	37	1	1	24
6	8	44	38	43	87	50	63	84	55	82	1	1	25
6	6	30	38	34	61	45	61	70	32	68	1	1	26
5	4	33	19	25	65	41	43	60	32	52	1	1	27
5	6	29	17	35	69	41	34	0	5	46	1	1	28
6	8	33	33	38	63	42	61	57	45	66	1	1	29
4	4	28	25	30	41	40	45	32	27	53	1	1	30
3	5	16	20	30	45	48	43	0	20	36	1	1	31
4	8	26	24	29	44	34	57	18	21	50	1	1	32
3	5	38	25	35	40	46	60	49	41	63	1	1	33
4	6	23	19	43	78	47	55	70	30	42	1	1	34
8	8	41	39	44	72	53	59	71	50	80	1	1	35
7	4	33	36	35	81	60	62	87	52	69	1	1	36

TABLE XVII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
4	8	11	19	30	41	40	41	22	21	30	1	1	37
5	6	20	21	34	25	54	59	48	38	41	1	1	38
4	6	28	20	35	51	32	58	44	44	48	1	1	39
5	6	34	29	45	74	50	55	26	39	63	1	1	40
7	6	29	34	35	76	41	78	42	34	63	1	1	41
3	5	34	18	35	77	50	55	18	20	52	1	1	42
8	8	32	27	43	56	44	61	86	50	59	2	1	43
3	5	21	29	36	42	22	51	27	24	50	1	1	44
3	3	19	20	34	47	23	57	37	24	39	1	1	45
3	4	29	25	32	54	28	69	44	27	54	2	1	46
5	4	34	16	35	72	54	42	62	33	50	1	1	47
2	3	11	7	25	33	47	46	0	5	18	1	1	48
2	3	13	25	33	55	39	61	16	21	38	1	1	49
6	8	32	35	44	80	36	49	20	40	67	2	1	50
2	4	10	17	4	38	14	43	0	7	27	1	1	51
5	8	28	28	29	56	40	56	56	37	56	2	1	52
6	6	29	33	43	97	51	56	38	48	62	1	1	53
4	5	27	18	34	48	27	59	17	4	45	1	1	54
8	8	41	39	40	83	55	60	90	45	80	1	1	55
6	8	32	30	38	80	52	58	62	35	62	1	1	56
8	8	36	33	39	75	53	62	86	54	69	1	1	57
6	8	20	30	41	80	24	72	32	34	50	2	1	58
4	4	29	26	29	56	55	52	29	29	55	1	2	59
8	8	31	34	44	37	28	64	80	45	65	2	2	60
2	3	21	19	33	36	32	45	33	28	40	1	2	61
6	8	39	27	43	66	48	53	76	46	66	1	2	62
6	6	18	20	30	59	43	54	47	32	38	1	2	63
5	8	24	18	39	44	49	69	43	40	42	1	2	64
4	5	13	19	28	27	47	37	36	35	32	1	2	65
3	5	23	28	41	87	59	61	6	30	51	1	2	66
2	4	22	17	33	12	35	54	26	29	39	1	2	67
8	8	28	30	38	42	34	62	68	49	58	2	2	68
5	6	27	24	31	59	30	45	40	32	51	1	2	69
3	5	24	29	31	30	44	52	0	22	43	1	2	70
4	5	23	21	35	55	23	52	16	18	44	1	2	71
3	6	34	26	40	68	56	53	74	40	60	1	2	72
3	2	23	9	29	53	43	52	42	22	32	1	2	73
4	8	36	31	36	64	34	50	67	48	67	1	3	74
4	6	36	27	42	51	47	75	62	48	63	1	3	75
4	4	30	24	38	63	33	51	47	26	54	1	3	76
5	6	39	34	43	68	48	42	51	22	73	1	3	77
5	8	40	28	39	74	48	66	59	52	68	2	3	78

TABLE XVII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
3	4	21	18	22	27	46	40	9	0	39	1	3	79
3	6	27	30	37	81	50	71	54	48	57	1	3	80
4	5	20	23	30	61	42	53	6	24	43	1	3	81
6	6	25	30	40	67	42	81	54	47	55	1	3	82
8	8	35	31	42	82	32	58	73	47	66	1	3	83
7	8	19	36	35	86	55	58	19	38	55	1	3	84
2	5	24	33	34	12	17	40	21	7	57	1	3	85
4	7	37	31	26	76	53	69	46	44	68	1	3	86
7	6	35	35	43	72	57	55	40	37	70	1	3	87
5	6	19	23	30	43	20	57	16	23	42	2	3	88
4	6	15	22	42	63	32	52	28	17	37	1	3	89
8	8	34	36	40	85	54	57	50	47	70	1	3	90
2	3	16	20	31	43	26	38	0	10	36	1	3	91
5	8	37	35	42	87	45	66	42	47	72	2	3	92
3	6	32	27	34	63	55	45	20	30	59	1	3	93
8	8	42	39	41	83	56	67	80	69	81	1	3	94
7	8	25	28	39	72	32	65	29	23	53	1	3	95
4	5	29	25	37	33	44	62	46	45	54	1	3	96
5	8	33	30	46	68	47	49	76	48	63	1	3	97
6	6	40	32	44	80	57	60	70	48	72	1	3	98
5	8	26	23	38	78	51	71	52	38	49	1	3	99
8	8	34	39	43	52	37	55	74	45	73	1	3	100
3	6	36	28	36	88	50	56	72	26	64	1	3	101
4	8	35	18	45	72	48	60	44	24	53	1	3	102
6	6	27	29	44	72	52	76	34	37	56	1	3	103
4	6	34	34	41	60	51	50	42	37	68	1	3	104
8	6	32	32	41	53	42	45	35	44	64	2	3	105
4	6	34	28	36	46	37	48	58	29	62	1	3	106
5	6	27	24	45	58	17	84	56	48	51	2	3	107
7	8	37	30	45	78	48	59	70	46	67	1	3	108
3	6	20	23	35	59	38	64	67	26	43	1	3	109
6	7	32	30	38	48	40	58	37	39	62	1	3	110
5	8	40	35	44	86	55	49	83	50	75	1	3	111
4	6	30	35	38	84	50	41	65	33	65	1	3	112
8	8	41	32	40	84	42	61	86	48	73	1	3	113
2	6	29	22	34	79	52	49	1	29	51	1	3	114
5	8	28	14	42	71	40	50	24	32	42	1	3	115
4	6	33	31	27	62	33	51	42	38	64	1	3	116
4	8	21	25	34	20	42	50	44	8	46	1	3	117
2	4	12	19	21	22	29	58	16	17	31	1	3	118
3	4	30	26	26	60	39	31	50	36	56	1	3	119
4	8	21	31	33	57	24	71	76	32	52	2	3	120
3	6	29	21	37	46	47	72	68	42	50	1	3	121

TABLE XVII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
6	6	36	27	45	79	33	65	48	45	63	2	3	122
4	8	25	25	43	89	38	98	53	37	50	2	3	123
4	7	16	25	36	64	49	49	36	20	41	1	3	124
5	6	31	39	27	55	51	60	47	43	70	1	3	125
2	5	19	6	35	57	53	49	10	11	25	1	3	126
7	8	23	29	42	57	27	94	76	61	52	2	3	127
5	6	30	28	42	52	44	61	50	32	58	1	3	128
2	3	20	26	38	58	40	58	78	26	46	1	3	129
2	4	29	11	24	47	25	48	72	43	40	2	3	130
2	4	8	16	34	78	45	53	0	2	24	1	3	131
4	8	19	24	32	30	13	82	73	37	43	2	3	132
6	8	24	22	38	91	58	46	18	43	46	1	3	133
4	5	16	21	38	65	36	49	39	29	27	1	3	134
2	6	18	23	27	35	29	47	18	23	41	1	3	135
2	5	23	15	27	72	44	35	3	27	38	1	3	136
4	5	23	19	30	53	37	45	37	26	42	1	3	137
8	8	33	33	44	67	60	44	20	27	66	1	3	138
2	4	9	5	18	26	12	33	39	17	14	1	3	139
2	5	15	17	29	38	53	61	32	24	32	1	3	140
4	4	19	24	27	60	36	60	18	15	43	1	3	141
6	6	29	33	31	66	45	58	40	40	62	1	3	142
2	5	29	25	34	70	39	37	46	32	54	1	3	143
4	4	33	21	29	36	29	52	44	41	54	2	3	144

TABLE XVIII

SIMPLE CORRELATIONS OF GEOMETRY GRADES AND DAT FACTORS
WITH PHYSICS GRADES FROM THE PHYSICS POPULATION
OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry	.68	.70	.52	.73	.81	.65
Verbal	.57	.62	.30	.69	.35	.51
Numerical	.65	.66	.64	.71	.52	.64
Abstract	.46	.45	.51	.36	.42	.59
Space	.40	.49	-.05	.46	.08	.42
Mechanical	.23	.35	.29	.31	-.26	.25
Clerical	.31	.36	-.11	.34	.43	.30
Spelling	.47	.48	.27	.59	.65	.33
Sentences	.59	.59	.56	.62	.71	.58
V + N	.67	.69	.58	.77	.54	.62

TABLE XIX

MEANS OF PHYSICS GRADES, GEOMETRY GRADES, AND DAT FACTORS FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Physics	4.73	4.61	5.55	5.10	4.40	4.49
Geometry	6.09	5.93	7.05	6.07	5.53	6.23
Verbal	27.55	27.46	28.68	28.05	25.27	27.62
Numerical	26.04	25.83	27.64	26.41	23.13	26.35
Abstract	35.75	35.56	37.05	35.48	34.93	36.14
Space	60.58	60.92	59.59	62.22	48.73	61.75
Mechanical	41.96	43.89	31.45	42.83	41.73	41.30
Clerical	55.99	54.32	65.00	55.81	53.67	56.62
Spelling	44.41	42.59	55.14	45.19	41.07	44.48
Sentences	33.67	32.46	41.64	33.64	33.13	33.80
V + N	53.45	53.13	56.32	54.47	47.73	53.83

TABLE XX

VARIANCES OF PHYSICS GRADES, GEOMETRY GRADES, AND DAT FACTORS FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Physics	3.54	3.55	3.21	3.57	3.69	3.40
Geometry	2.64	2.57	2.14	2.94	3.55	2.21
Verbal	67.61	74.00	38.99	76.37	40.92	66.41
Numerical	57.45	62.31	30.15	68.28	40.55	51.63
Abstract	45.48	45.33	45.66	51.94	29.78	44.29
Space	363.27	375.62	307.78	359.93	356.78	343.96
Mechanical	117.93	100.47	84.16	106.15	120.21	129.35
Clerical	133.29	100.37	225.43	98.09	64.67	177.90
Spelling	599.95	602.51	452.79	712.23	613.92	519.97
Sentences	189.43	191.51	137.86	221.57	86.12	189.25
V + N	207.87	231.92	85.37	240.32	125.50	195.86

TABLE XXI

MULTIPLE CORRELATIONS INVOLVING COMBINATIONS OF TWO VARIABLES WITH PHYSICS GRADES FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Combinations of Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
2 and 3	.74	.75	.61	.82	.81	.69
2 and 4	.76	.77	.65	.80	.81	.75
2 and 5	.70	.71	.62	.74	.83	.71
2 and 6	.70	.73	.56	.75	.81	.66
2 and 7	.69	.71	.54	.76	.84	.65
2 and 8	.69	.72	.59	.75	.81	.65
2 and 9	.72	.73	.53	.80	.83	.65
2 and 10	.74	.75	.68	.79	.81	.71
2 and 11	.77	.78	.67	.84	.81	.73
3 and 4	.68	.70	.66	.77	.53	.65
3 and 5	.60	.63	.54	.69	.43	.64
3 and 6	.59	.65	.32	.71	.35	.55
3 and 7	.57	.62	.32	.70	.46	.51
3 and 8	.61	.65	.30	.71	.48	.57
3 and 9	.59	.63	.37	.71	.65	.51
3 and 10	.64	.66	.56	.72	.71	.60
3 and 11	.68	.70	.66	.77	.62	.64
4 and 5	.68	.68	.66	.71	.54	.72
4 and 6	.67	.70	.71	.73	.52	.67
4 and 7	.65	.68	.64	.73	.59	.64
4 and 8	.66	.67	.64	.71	.59	.66
4 and 9	.68	.68	.71	.75	.75	.64
4 and 10	.71	.71	.76	.75	.74	.70
4 and 11	.68	.70	.66	.77	.56	.65
5 and 6	.50	.54	.63	.48	.42	.61
5 and 7	.47	.48	.53	.40	.51	.60
5 and 8	.50	.51	.56	.46	.47	.60
5 and 9	.56	.54	.59	.60	.66	.60
5 and 10	.62	.61	.64	.62	.71	.69
5 and 11	.68	.70	.63	.77	.54	.70
6 and 7	.41	.50	.36	.48	.35	.42
6 and 8	.47	.55	.12	.54	.43	.48
6 and 9	.56	.60	.27	.66	.65	.49
6 and 10	.62	.64	.56	.66	.71	.61
6 and 11	.68	.71	.65	.77	.56	.65

TABLE XXI (continued)

Combinations of Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
7 and 8	.39	.45	.29	.47	.53	.40
7 and 9	.51	.54	.41	.61	.69	.42
7 and 10	.60	.60	.59	.63	.79	.60
7 and 11	.67	.70	.60	.77	.62	.62
8 and 9	.50	.53	.33	.62	.72	.37
8 and 10	.60	.61	.58	.65	.73	.58
8 and 11	.69	.71	.58	.77	.59	.66
9 and 10	.60	.60	.57	.65	.72	.58
9 and 11	.68	.70	.62	.77	.68	.62
10 and 11	.70	.71	.65	.78	.72	.66

TABLE XXII

MULTIPLE REGRESSION EQUATIONS, F RATIOS, STANDARD ERRORS OF ESTIMATE AND COEFFICIENTS OF DETERMINATION FROM THE PHYSICS POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

NOTE: The table should be read as follows: The two independent variables (X_1 and X_2) predict the dependent variable (Y', physics grade) in the form $Y' = A + B_1X_1 + B_2X_2$; the F, S.E., and R^2 are respectively the F ratio, standard error of estimate, and multiple coefficient of determination.

Variables		Total						Males					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.62	.07	-1.06	85.80	1.27	.55	.61	.07	-1.03	79.50	1.25	.57
2	4	.54	.10	-1.10	95.21	1.24	.57	.57	.09	-1.19	88.76	1.21	.60
2	5	.69	.05	-1.35	69.49	1.34	.50	.73	.04	-1.33	62.23	1.33	.51
2	6	.72	.01	- .56	67.04	1.36	.49	.71	.02	- .88	67.11	1.31	.53
2	7	.77	.02	- .79	65.49	1.36	.48	.77	.03	-1.12	61.80	1.33	.51
2	8	.76	.01	- .69	63.95	1.37	.48	.77	.03	-1.73	64.48	1.32	.52
2	9	.68	.02	- .20	73.89	1.32	.51	.71	.02	- .37	69.66	1.29	.54
2	10	.60	.05	- .44	86.38	1.27	.55	.63	.04	- .54	77.14	1.26	.56
2	11	.52	.05	-1.36	101.27	1.21	.59	.52	.05	-1.32	93.72	1.19	.61
3	4	.06	.12	- .06	61.17	1.39	.46	.07	.11	- .03	56.86	1.36	.49
3	5	.10	.07	- .45	40.61	1.51	.37	.11	.05	- .20	39.71	1.47	.40
3	6	.11	.02	.57	38.16	1.53	.35	.11	.02	.17	44.48	1.44	.43
3	7	.13	.00	1.04	34.00	1.56	.33	.12	.02	.23	38.37	1.48	.39
3	8	.12	.04	- .69	42.15	1.50	.37	.12	.04	-1.01	44.17	1.44	.42
3	9	.10	.01	1.21	38.49	1.52	.35	.11	.01	1.00	38.70	1.48	.40
3	10	.07	.05	.95	49.15	1.45	.41	.09	.04	.80	46.15	1.43	.43
3	11	-.06	.12	.02	61.32	1.39	.47	-.04	.11	.04	56.83	1.36	.49
4	5	.14	.06	- .97	59.72	1.39	.46	.14	.06	- .92	52.19	1.39	.47
4	6	.14	.02	- .05	57.03	1.41	.45	.13	.03	- .33	57.39	1.36	.49
4	7	.16	.01	.10	52.82	1.43	.43	.14	.03	- .50	50.41	1.40	.46
4	8	.15	.02	- .43	55.15	1.42	.44	.14	.03	- .60	48.98	1.41	.45
4	9	.14	.02	.45	59.74	1.39	.46	.13	.01	.55	50.75	1.40	.46
4	10	.12	.05	.16	71.66	1.33	.50	.11	.04	.30	59.34	1.35	.50
4	11	.06	.06	- .03	61.59	1.38	.47	.04	.07	.00	57.11	1.36	.49

TABLE XXII (continued)

Variables:		Total						Males					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
5	6	.10	.02	- .08	23.67	1.64	.25	.08	.03	- .14	24.87	1.60	.29
5	7	.12	.01	- .20	20.01	1.67	.22	.10	.04	- .63	18.40	1.66	.23
5	8	.11	.03	-1.01	23.02	1.65	.25	.10	.04	-1.55	20.57	1.64	.26
5	9	.09	.03	.38	31.51	1.58	.31	.08	.03	.65	25.26	1.59	.30
5	10	.06	.07	.34	44.62	1.48	.39	.06	.07	.50	36.34	1.50	.38
5	11	.04	.08	- .89	62.26	1.38	.47	.03	.08	- .67	57.90	1.36	.49
6	7	.04	.01	2.11	13.87	1.73	.16	.04	.03	1.01	20.37	1.64	.25
6	8	.04	.04	.33	20.06	1.67	.22	.04	.05	- .60	26.23	1.59	.30
6	9	.03	.03	1.51	32.49	1.57	.32	.04	.03	1.23	33.39	1.52	.36
6	10	.02	.07	1.77	44.24	1.49	.39	.03	.06	.97	40.82	1.47	.40
6	11	.01	.08	- .25	60.58	1.39	.46	.02	.07	- .46	62.40	1.33	.51
7	8	.04	.05	.06	12.88	1.74	.15	.05	.06	- .79	15.63	1.69	.21
7	8	.03	.03	1.87	24.42	1.63	.26	.05	.03	1.18	24.82	1.60	.29
7	10	.01	.08	1.50	39.50	1.52	.36	.02	.07	1.24	33.85	1.52	.36
7	11	-.00	.09	.04	58.48	1.40	.45	.02	.08	- .47	57.45	1.36	.49
8	9	.03	.03	1.73	23.71	1.64	.25	.04	.03	.87	23.87	1.61	.28
8	10	.02	.08	1.27	39.86	1.51	.36	.03	.07	.66	35.25	1.51	.37
8	11	.02	.08	-1.09	63.79	1.37	.48	.03	.08	-1.15	60.39	1.34	.50
9	10	.01	.07	1.98	39.40	1.52	.36	.01	.07	1.98	33.52	1.52	.36
9	11	.01	.08	.12	60.38	1.39	.46	.00	.08	.10	56.37	1.36	.48
10	11	.04	.07	.04	68.19	1.35	.49	.03	.07	.07	61.50	1.34	.51

Variables:		Females						Topeka West					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.66	.09	-1.76	5.66	1.49	.37	.57	.09	- .97	56.81	1.10	.67
2	4	.20	.17	- .66	7.02	1.43	.42	.52	.10	- .63	50.26	1.43	.65
2	5	.46	.10	-1.26	5.82	1.48	.38	.75	.04	- .76	33.37	1.29	.55
2	6	.71	-.02	1.85	4.27	1.56	.31	.71	.02	- .43	35.34	1.27	.56
2	7	.58	.03	.46	3.91	1.59	.29	.77	.04	-1.19	36.94	1.26	.57
2	8	.74	-.03	2.60	4.98	1.53	.34	.76	.03	-1.43	35.37	1.27	.56
2	9	.59	.01	.80	3.74	1.60	.28	.65	.03	.05	48.26	1.16	.64
2	10	.48	.07	- .76	8.11	1.38	.46	.62	.04	- .16	46.49	1.17	.63

TABLE XXII (continued)

Variables :		Females						: Topeka West					
X_1	X_2	: B_1	B_2	A	F	S.E.	R^2	: B_1	B_2	A	F	S.E.	R^2
2	11	.43	.09	-2.48	7.68	1.40	.45	.46	.06	-1.12	64.36	1.05	.70
3	4	.04	.20	-1.17	7.25	1.42	.43	.08	.10	.02	39.19	1.23	.59
3	5	.05	.12	- .56	3.97	1.58	.29	.15	.01	.77	24.82	1.39	.47
3	6	.09	-.01	3.60	1.08	1.79	.10	.13	.02	.30	27.58	1.36	.50
3	7	.06	.03	2.97	1.09	1.78	.10	.14	.01	.63	25.01	1.39	.48
3	8	.08	-.00	3.16	.92	1.80	.09	.14	.04	- .78	28.21	1.35	.51
3	9	.07	.02	2.36	1.51	1.75	.14	.11	.02	1.12	28.24	1.35	.51
3	10	-.01	.09	2.20	4.42	1.56	.32	.11	.04	.85	30.20	1.33	.52
3	11	-.15	.20	-1.17	7.25	1.41	.43	-.02	.10	.02	39.19	1.23	.59
4	5	.17	.05	-1.09	7.30	1.42	.43	.16	.02	.39	28.13	1.35	.51
4	6	.25	-.03	.67	9.84	1.32	.51	.14	.02	.20	30.75	1.32	.53
4	7	.20	.01	- .37	6.67	1.44	.41	.15	.03	- .33	31.20	1.32	.53
4	8	.21	-.01	.29	6.71	1.44	.41	.16	.01	.35	28.06	1.35	.51
4	9	.22	.03	-1.86	9.73	1.32	.51	.13	.02	.87	34.72	1.28	.56
4	10	.17	.07	-2.01	13.34	1.22	.58	.12	.04	-.58	36.34	1.26	.57
4	11	.15	.04	-1.17	7.25	1.42	.43	.02	.08	.02	39.19	1.23	.59
5	6	.19	-.04	.93	6.20	1.47	.39	.04	.04	1.41	8.13	1.69	.23
5	7	.12	.03	- .03	3.79	1.59	.29	.07	.03	1.03	5.21	1.76	.16
5	8	.15	-.03	1.84	4.44	1.56	.32	.08	.05	- .77	7.20	1.71	.21
5	9	.14	.02	- .97	5.05	1.52	.35	.03	.04	2.26	15.53	1.53	.36
5	10	.09	.06	- .50	6.69	1.44	.41	.00	.08	2.36	17.21	1.51	.38
5	11	.08	.08	-1.97	6.26	1.46	.40	-.01	.10	.27	39.20	1.23	.59
6	7	-.03	.08	4.55	1.39	1.76	.13	.04	.03	1.44	8.35	1.68	.23
6	8	-.00	-.01	6.61	.13	1.87	.01	.04	.05	- .49	11.29	1.62	.29
6	9	.01	.02	3.80	.77	1.81	.07	.03	.04	1.53	21.80	1.44	.44
6	10	-.01	.09	2.29	4.44	1.56	.32	.02	.07	1.37	21.13	1.46	.43
6	11	-.03	.14	- .21	6.95	1.43	.42	.01	.09	- .28	40.38	1.22	.59
7	8	.05	-.00	4.11	.85	1.80	.08	.06	.07	-1.19	7.78	1.70	.22
7	9	.06	.02	2.30	1.88	1.72	.17	.03	.04	2.24	15.97	1.53	.37
7	10	.03	.08	1.16	4.98	1.53	.34	.02	.07	1.76	17.96	1.50	.40
7	11	-.03	.14	-1.00	5.25	1.51	.36	.01	.09	- .37	39.70	1.23	.59
8	9	-.02	.03	5.63	1.17	1.78	.11	.04	.04	1.34	17.08	1.51	.38

TABLE XXII (continued)

Variables :		Females						Topeka West					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
8	10	-.02	.09	3.11	4.10	1.53	.34	.04	.07	.60	19.93	1.46	.42
8	11	.01	.12	-1.47	4.93	1.53	.34	.01	.09	- .63	39.87	1.23	.59
9	10	-.01	.10	2.07	4.55	1.55	.32	.02	.05	2.47	19.85	1.47	.42
9	11	.02	.11	-1.68	6.05	1.47	.39	.01	.08	.20	40.82	1.22	.60
10	11	.05	.08	- .95	6.99	1.43	.42	.02	.08	.06	42.18	1.21	.61
Variables :		Highland Park						Topeka High					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.85	-.02	.12	11.18	1.23	.65	.65	.06	-1.30	31.57	1.35	.48
2	4	.80	.01	- .27	11.12	1.23	.65	.55	.11	-1.78	42.43	1.25	.56
2	5	.99	-.09	1.96	12.85	1.17	.68	.57	.09	-2.42	33.60	1.33	.50
2	6	.82	-.00	- .05	11.10	1.23	.65	.71	.02	- .95	26.80	1.40	.44
2	7	.81	-.04	1.61	14.19	1.13	.70	.77	.02	- .95	25.41	1.41	.43
2	8	.82	-.00	- .13	11.08	1.23	.65	.78	.01	- .74	24.77	1.42	.42
2	9	.66	.02	- .10	13.77	1.14	.70	.76	.01	- .57	25.28	1.42	.43
2	10	.68	.03	- .52	11.54	1.21	.66	.59	.05	- .71	34.51	1.32	.50
2	11	.80	.01	- .31	11.12	1.23	.65	.55	.05	-1.75	39.25	1.27	.54
3	4	.03	.14	.42	2.30	1.76	.28	.04	.13	- .21	25.35	1.42	.43
3	5	.04	.12	- .68	1.35	1.87	.18	.06	.13	-1.77	23.58	1.44	.41
3	6	.11	-.01	1.90	.83	1.94	.12	.09	.02	.51	14.88	1.56	.30
3	7	.11	-.05	3.75	1.63	1.84	.21	.11	.01	1.10	11.95	1.61	.26
3	8	.07	.09	-1.83	1.80	1.82	.23	.11	.04	- .53	16.13	1.53	.32
3	9	-.02	.05	2.65	4.49	1.57	.43	.11	.01	1.30	12.06	1.61	.26
3	10	-.01	.15	- .38	6.12	1.46	.51	.05	.06	1.17	19.30	1.49	.36
3	11	-.20	.19	.18	3.67	1.63	.38	-.08	.13	- .01	23.87	1.43	.41
4	5	.13	.06	- .72	2.49	1.74	.29	.12	.11	-2.44	36.80	1.30	.52
4	6	.16	-.00	.84	2.42	1.77	.27	.14	.02	- .63	27.54	1.39	.45
4	7	.16	.05	2.74	3.21	1.67	.35	.16	.01	- .05	23.36	1.44	.41
4	8	.13	.07	-2.40	3.26	1.67	.35	.15	.02	- .91	25.98	1.41	.43
4	9	.12	.04	- .04	7.74	1.37	.56	.16	.01	.14	23.50	1.44	.41
4	10	.07	.12	-1.27	7.11	1.40	.54	.11	.05	- .12	32.18	1.34	.49
4	11	.07	.06	- .09	2.71	1.72	.31	.10	.04	- .14	25.03	1.42	.42
5	6	.15	-.01	- .69	1.31	1.88	.18	.14	.01	-1.59	19.91	1.48	.37

TABLE XXII (continued)

Variables		Highland Park						Topeka High					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
5	7	.15	-.05	1.15	2.08	1.79	.26	.16	.01	-1.65	18.81	1.50	.36
5	8	.08	.07	-2.05	1.69	1.83	.22	.16	.01	-1.84	19.16	1.50	.36
5	9	.04	.05	1.06	4.64	1.56	.44	.15	.01	-1.41	19.36	1.50	.36
5	10	-.02	.15	- .01	6.16	1.46	.51	.12	.05	-1.47	30.87	1.35	.48
5	11	.01	.09	- .24	2.48	1.74	.29	.10	.06	-2.22	32.20	1.34	.49
6	7	.03	-.07	5.90	.82	1.94	.12	.04	.00	1.83	7.32	1.70	.18
6	8	.00	.10	-1.19	1.40	1.87	.19	.04	.03	.40	9.94	1.64	.23
6	9	.00	.05	2.21	4.46	1.57	.43	.04	.02	1.32	10.60	1.63	.24
6	10	.00	.15	- .66	6.16	1.46	.51	.02	.07	1.04	19.85	1.49	.37
6	11	-.02	.10	.25	2.72	1.72	.31	.02	.07	- .48	24.25	1.43	.42
7	8	-.05	.11	.70	2.36	1.76	.28	.04	.04	.27	6.48	1.71	.16
7	9	-.04	.05	3.98	5.41	1.50	.47	.04	.03	1.53	7.28	1.70	.18
7	10	-.06	.16	1.83	10.22	1.26	.63	.02	.07	1.07	18.67	1.50	.35
7	11	-.05	.10	2.02	3.73	1.63	.38	-.00	.08	.07	21.77	1.46	.39
8	9	.07	.05	-1.30	6.28	1.45	.51	.03	.02	2.05	5.55	1.73	.14
8	10	.04	.13	-2.30	6.83	1.42	.53	.00	.08	1.70	17.27	1.52	.34
8	11	.06	.07	-2.51	3.22	1.67	.35	.03	.08	-1.27	25.58	1.41	.43
9	10	.02	.11	.05	6.47	1.44	.52	-.01	.09	1.92	17.58	1.52	.34
9	11	.04	.04	.79	5.21	1.52	.46	-.00	.08	.06	21.77	1.46	.39
10	11	.13	.02	- .98	6.38	1.44	.52	.04	.06	.12	26.57	1.40	.44

APPENDIX B

DATA AND RESULTS OF THE CHEMISTRY POPULATION

A List of Abbreviated Titles

NOTE: The variables in Tables XXIII, XXVII, and XXVIII are denoted by numbers; the chemistry grade is 1, geometry grade - 2, verbal reasoning - 3, numerical ability - 4, abstract reasoning - 5, space relations - 6, mechanical reasoning - 7, clerical speed and accuracy - 8, spelling - 9, sentences - 10, and verbal reasoning plus numerical ability (V + N) - 11.

TABLE XXIII

GEOMETRY GRADES AND DAT RAW DATA FOR THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

NOTE: In the sex column, males are 1 and females are 2; in the school column, Topeka West is 1, Highland Park is 2, and Topeka High is 3.

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
8	8	42	35	41	80	49	49	57	61	77	1	1	1
8	8	32	26	25	47	31	75	77	43	58	2	1	2
5	5	25	31	27	27	46	60	62	26	56	1	1	3
7	6	42	33	46	76	45	43	77	45	75	1	1	4
6	6	22	20	34	87	53	53	20	29	42	1	1	5
8	8	19	31	29	68	41	56	27	31	50	1	1	6
6	4	21	10	44	67	55	45	55	67	31	1	1	7
4	6	30	27	35	83	52	69	11	24	57	1	1	8
8	6	19	29	46	85	54	56	27	24	48	1	1	9
8	8	38	36	36	76	57	50	54	35	74	1	1	10
8	8	37	35	40	71	31	44	78	67	72	2	1	11
4	3	21	11	33	10	49	52	10	17	32	1	1	12
6	5	20	20	29	57	37	64	19	29	40	1	1	13
4	7	21	28	34	78	35	50	22	14	49	2	1	14
2	6	24	20	44	76	52	50	84	31	44	1	1	15
7	8	39	38	39	76	53	69	46	50	77	1	1	16
6	6	27	21	26	58	51	34	27	18	48	1	1	17
8	8	41	36	43	83	41	68	95	59	77	1	1	18
5	6	15	8	28	46	26	52	26	20	23	1	1	19
4	6	28	31	43	68	51	51	63	38	59	1	1	20
7	6	32	36	36	25	32	51	76	39	68	1	1	21
8	8	41	32	41	73	47	75	62	40	73	1	1	22
8	6	30	32	35	47	41	71	52	30	62	1	1	23
6	2	17	20	39	59	32	59	23	20	37	1	1	24
6	8	44	38	43	87	50	63	84	55	82	1	1	25
8	6	30	38	34	61	45	61	70	32	68	1	1	26
6	4	33	19	25	65	41	43	60	32	52	1	1	27
6	8	33	33	38	63	42	61	57	45	66	1	1	28
5	4	28	25	30	41	40	45	32	27	53	1	1	29
3	5	16	20	30	45	48	43	0	20	36	1	1	30
6	8	26	24	29	44	34	57	18	21	50	1	1	31
5	5	38	25	35	40	46	60	49	41	63	1	1	32
7	6	23	19	43	78	47	55	70	30	42	1	1	33
8	8	41	39	44	72	53	59	71	50	80	1	1	34
7	4	33	36	35	81	60	62	87	52	69	1	1	35
5	8	11	19	30	41	40	41	22	21	30	1	1	36

TABLE XXIII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
5	6	20	21	34	25	54	59	48	38	41	1	1	37
5	6	28	20	35	51	32	58	44	44	48	1	1	38
6	6	34	29	45	74	50	55	26	39	63	1	1	39
5	6	29	34	35	76	41	78	42	34	63	1	1	40
3	5	34	18	35	77	50	55	18	20	52	1	1	41
8	8	32	27	43	56	44	61	86	50	59	2	1	42
6	5	21	29	36	42	22	51	27	24	50	1	1	43
8	8	42	39	46	32	27	71	89	66	81	2	1	44
6	5	35	30	40	52	48	64	27	49	65	2	1	45
8	7	34	30	39	61	37	58	36	45	64	2	1	46
5	4	14	21	35	61	38	68	0	32	35	1	1	47
8	7	21	25	36	87	53	38	0	30	46	1	1	48
6	5	16	19	25	54	22	69	30	28	35	2	1	49
6	6	31	21	38	80	62	52	52	52	52	2	1	50
5	5	16	12	36	52	30	57	9	22	28	2	1	51
5	4	33	27	23	58	29	60	94	50	60	2	1	52
6	4	18	27	19	71	36	63	49	47	45	2	1	53
5	6	25	20	37	59	24	49	18	29	45	1	1	54
5	5	35	27	36	62	28	52	65	53	62	2	1	55
4	8	25	27	43	92	35	60	47	51	52	2	1	56
4	2	18	13	23	47	15	45	36	17	31	2	1	57
3	6	35	32	39	45	27	52	67	38	67	2	1	58
4	5	14	19	36	57	29	45	28	14	33	2	1	59
4	6	23	18	21	12	33	57	66	23	41	2	1	60
4	5	22	27	35	34	32	50	40	37	49	2	1	61
7	7	25	31	40	52	44	62	24	35	56	1	1	62
6	6	25	20	38	81	48	44	17	26	45	1	1	63
5	5	24	21	34	48	36	46	0	22	45	1	1	64
6	6	31	14	26	42	30	64	56	41	45	2	1	65
5	6	30	27	35	75	53	49	36	33	57	1	1	66
6	5	21	19	33	23	34	57	4	32	40	2	1	67
6	6	14	26	25	54	50	53	0	30	40	1	1	68
8	6	37	18	34	76	43	60	52	40	55	2	1	69
7	6	25	30	40	68	41	64	51	41	55	2	1	70
6	6	24	33	34	66	37	62	64	37	57	2	1	71
7	6	36	31	43	55	36	67	61	46	67	2	1	72
7	8	29	26	35	62	35	65	56	53	55	2	1	73
8	8	42	38	46	75	28	75	70	61	80	2	1	74
7	8	30	26	45	55	51	52	38	26	56	1	1	75
8	8	25	33	39	51	21	62	60	49	58	2	1	76
6	4	28	21	36	37	24	55	59	33	49	2	1	77
5	4	33	15	36	46	30	75	42	57	48	2	1	78
4	6	19	14	36	61	30	44	13	39	33	2	1	79

TABLE XXIII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
6	2	13	10	33	47	26	53	48	24	23	2	1	80
2	3	13	22	39	64	35	78	33	24	35	1	1	81
3	7	33	12	35	32	33	63	15	32	45	2	1	82
8	6	30	34	38	89	36	86	37	52	64	2	1	83
4	6	30	28	34	56	30	72	48	38	58	2	1	84
4	6	30	19	38	58	32	64	36	40	49	2	1	85
5	5	41	26	42	74	48	50	77	42	67	1	1	86
7	8	42	36	39	84	53	62	56	52	78	1	1	87
6	6	18	18	35	54	18	62	53	34	36	2	1	88
2	4	25	23	49	50	43	67	46	33	48	1	1	89
3	4	15	19	36	60	38	54	59	31	34	2	1	90
7	6	20	22	34	76	26	82	55	30	42	2	1	91
4	6	29	19	39	55	33	57	57	36	48	2	1	92
3	4	23	21	26	29	18	66	30	34	44	2	1	93
6	4	36	35	40	64	46	52	61	26	71	1	1	94
8	8	33	25	40	54	36	56	66	54	48	2	1	95
7	8	40	30	39	56	27	79	66	56	70	2	1	96
5	6	23	30	39	77	54	36	26	33	53	1	1	97
4	3	10	16	31	11	17	54	36	4	26	1	1	98
7	5	25	19	27	51	21	58	12	27	44	2	1	99
5	4	27	30	38	83	58	54	0	39	57	1	1	100
7	8	29	22	33	62	18	69	70	55	51	2	1	101
7	4	23	18	35	53	40	37	15	35	41	1	1	102
6	7	28	25	39	53	47	50	47	30	53	1	1	103
8	8	25	34	38	86	45	54	61	51	59	2	1	104
4	5	19	22	38	58	56	49	12	24	41	1	1	105
6	8	31	23	35	62	29	77	76	48	54	2	1	106
4	6	21	35	36	72	41	67	41	28	56	1	1	107
5	6	39	36	43	73	43	47	84	56	75	2	1	108
7	4	21	31	38	55	28	55	2	33	52	1	1	109
6	4	16	32	38	67	22	49	36	33	48	1	1	110
2	2	15	16	31	59	17	54	26	14	21	1	1	111
2	4	9	26	3	47	27	44	43	20	35	2	1	112
7	8	32	27	34	60	32	60	32	32	59	2	1	113
8	8	31	34	44	37	28	64	80	45	65	2	2	114
2	3	21	19	33	36	32	45	33	28	40	1	2	115
7	8	39	27	43	66	48	53	76	46	66	1	2	116
5	6	18	20	30	59	43	54	47	32	38	1	2	117
6	8	24	18	39	44	49	69	43	40	42	1	2	118
4	5	13	19	28	27	47	37	36	35	32	1	2	119
3	5	23	28	41	87	59	61	6	30	51	1	2	120
2	4	22	17	33	12	35	54	26	29	39	1	2	121
8	8	28	30	38	42	34	62	68	49	58	2	2	122

TABLE XXIII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
5	6	27	24	31	59	30	45	40	32	51	1	2	123
3	5	24	29	31	30	44	52	0	22	43	1	2	124
2	3	29	20	36	59	46	36	79	31	49	1	2	125
3	6	24	34	41	63	19	56	44	37	58	2	2	126
3	3	12	19	38	29	29	41	58	36	31	2	2	127
4	4	20	15	25	50	43	61	24	24	35	1	2	128
4	6	16	16	13	22	42	45	3	14	32	1	2	129
2	2	18	20	29	54	35	49	14	22	38	1	2	130
4	4	21	16	20	9	17	61	49	29	37	2	2	131
5	4	24	28	39	30	33	46	66	38	52	1	2	132
3	2	7	6	15	32	7	67	0	8	13	2	2	133
6	6	27	22	40	63	44	60	50	32	49	2	2	134
3	4	32	24	33	52	34	84	31	50	56	2	2	135
3	2	13	10	0	18	9	62	66	9	23	2	2	136
4	6	27	26	36	62	36	66	47	25	53	2	2	137
5	6	31	34	39	73	43	71	86	60	65	2	2	138
4	4	15	24	20	43	22	65	38	14	39	2	2	139
2	6	16	25	34	81	38	46	9	15	41	1	2	140
4	6	15	30	0	68	26	82	13	16	45	2	2	141
6	6	36	27	42	51	47	75	62	48	63	1	3	142
5	4	30	24	38	63	33	51	47	26	54	1	3	143
6	6	39	34	43	68	48	42	51	22	73	1	3	144
7	8	40	28	39	74	48	66	59	52	68	2	3	145
3	4	21	18	22	27	46	40	9	0	39	1	3	146
3	6	27	30	37	81	50	71	54	48	57	1	3	147
5	5	20	23	30	61	42	53	6	24	43	1	3	148
8	6	25	30	40	67	42	81	54	47	55	1	3	149
7	8	35	31	42	82	32	58	73	47	66	1	3	150
8	8	19	36	35	86	55	58	19	38	55	1	3	151
6	5	24	33	34	12	17	40	21	7	57	1	3	152
6	7	37	31	26	76	53	69	46	44	68	1	3	153
4	6	35	35	43	72	57	55	40	37	70	1	3	154
6	6	19	23	30	43	20	57	16	23	42	2	3	155
6	6	15	22	42	63	32	52	28	17	37	1	3	156
8	8	34	36	40	85	54	57	50	47	70	1	3	157
2	3	16	20	31	43	26	38	0	10	36	1	3	158
8	8	37	35	42	87	45	66	42	47	72	2	3	159
5	6	32	27	34	63	55	45	20	30	59	1	3	160
8	8	42	39	41	83	56	67	80	69	81	1	3	161
8	8	25	28	39	72	32	65	29	23	53	1	3	162
6	5	29	25	37	33	44	62	46	45	54	1	3	163
4	8	33	30	46	68	47	49	76	48	63	1	3	164
8	6	40	32	44	80	57	60	70	48	72	1	3	165

TABLE XXIII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
6	8	26	23	38	78	51	71	52	38	49	1	3	166
8	8	34	39	43	52	37	55	74	45	73	1	3	167
4	6	36	28	36	88	50	56	72	26	64	1	3	168
5	8	35	18	45	72	48	60	44	24	53	1	3	169
6	6	27	29	44	72	52	76	34	37	56	1	3	170
4	6	34	34	41	60	51	50	42	37	68	1	3	171
8	6	32	32	41	53	42	45	35	44	64	2	3	172
8	6	34	28	36	46	37	48	58	29	62	1	3	173
8	6	27	24	45	58	17	84	56	48	51	2	3	174
8	8	37	30	45	78	48	59	70	46	67	1	3	175
5	6	20	23	35	59	38	64	67	26	43	1	3	176
6	7	32	30	38	48	40	58	37	39	62	1	3	177
8	8	40	35	44	86	55	49	83	50	75	1	3	178
6	6	30	35	38	84	50	41	65	33	65	1	3	179
8	8	41	32	40	84	42	61	86	48	73	1	3	180
4	6	29	22	34	79	52	49	1	29	51	1	3	181
7	8	28	14	42	71	40	50	24	32	42	1	3	182
4	6	33	31	27	62	33	51	42	38	64	1	3	183
8	8	21	25	34	20	42	50	44	8	46	1	3	184
4	4	12	19	21	22	29	58	16	17	31	1	3	185
2	4	30	26	26	60	39	31	50	36	56	1	3	186
8	8	21	31	33	57	24	71	76	32	52	2	3	187
4	6	29	21	37	46	47	72	68	42	50	1	3	188
8	6	36	27	45	79	33	65	48	45	63	2	3	189
4	6	23	28	26	16	43	48	72	13	51	1	3	190
7	6	24	32	38	57	28	60	80	42	56	1	3	191
6	8	41	35	31	70	0	50	60	46	76	1	3	192
7	8	25	20	35	53	53	55	56	50	45	1	3	193
5	8	18	19	34	69	40	72	60	31	37	2	3	194
7	8	25	30	39	55	30	61	72	53	55	2	3	195
6	6	20	28	36	72	35	55	55	29	48	2	3	196
3	4	28	27	36	79	31	65	49	25	55	1	3	197
4	4	19	24	30	39	41	42	12	19	43	1	3	198
3	3	1	18	26	13	8	65	46	36	19	2	3	199
5	4	28	15	33	66	43	56	4	27	43	1	3	200
3	4	20	21	24	61	44	48	13	43	41	1	3	201
7	4	28	30	29	38	26	65	80	44	58	1	3	202
7	8	32	33	43	72	50	56	57	53	65	1	3	203
4	4	19	20	33	40	47	31	33	11	39	1	3	204
4	2	15	19	31	52	28	65	33	19	34	2	3	205
2	4	23	12	21	38	28	57	31	20	35	1	3	206
6	5	25	30	39	81	20	81	74	51	55	2	3	207
4	4	25	20	38	77	30	47	19	27	45	2	3	208

TABLE XXIII (continued)

1	2	3	4	5	6	7	8	9	10	11	Sex	School	Student Number
6	6	24	25	34	70	26	61	86	36	49	2	3	209
7	4	24	26	25	45	37	40	6	17	50	1	3	210
2	5	24	13	34	44	43	32	36	29	37	1	3	211
5	5	36	23	45	76	46	43	23	24	59	1	3	212
6	6	27	31	23	36	15	65	80	47	58	2	3	213
5	3	19	18	40	49	27	66	38	46	37	2	3	214
5	6	25	25	30	64	38	53	84	33	50	2	3	215
4	6	9	19	41	42	29	55	38	36	28	2	3	216
7	5	20	13	35	73	28	66	27	25	33	2	3	217
4	4	22	20	22	26	28	66	32	23	42	1	3	218
4	2	14	16	21	63	35	52	42	15	30	1	3	219
8	6	28	21	38	71	35	62	90	49	49	2	3	220
7	8	28	24	35	67	38	62	30	35	52	2	3	221
8	8	34	30	40	62	35	65	54	40	64	2	3	222
3	4	20	22	35	36	29	56	25	23	42	2	3	223
4	4	32	26	30	58	39	55	52	49	58	1	3	224
6	6	40	31	46	48	27	58	86	55	71	2	3	225
5	4	27	6	33	52	23	54	74	28	33	2	3	226
6	7	34	23	34	13	27	32	73	47	57	2	3	227
6	4	28	10	34	67	34	44	18	33	38	1	3	228
8	8	31	31	42	42	26	77	58	55	62	2	3	229
4	6	34	30	40	56	23	41	57	35	64	2	3	230
8	7	30	29	38	71	57	65	49	40	59	1	3	231
4	4	31	25	42	82	48	62	56	44	56	2	3	232
5	6	29	29	31	62	39	56	58	26	58	2	3	233
7	6	18	23	39	58	27	55	5	16	41	2	3	234
6	6	25	16	29	47	27	50	66	32	41	2	3	235
8	8	23	24	30	52	36	49	12	31	47	1	3	236
5	5	15	24	31	7	43	49	26	17	39	2	3	237
6	6	30	18	40	71	52	48	38	36	48	1	3	238
4	6	16	21	37	49	11	64	32	14	37	2	3	239
4	3	8	10	10	16	12	57	38	6	18	2	3	240
5	5	22	23	36	53	26	65	63	44	45	2	3	241
6	8	25	32	36	45	36	50	40	27	23	1	3	242
3	6	19	10	29	20	16	55	35	17	29	2	3	243
6	5	27	23	41	86	44	48	94	61	50	2	3	244
4	6	22	26	27	48	25	60	29	19	48	1	3	245
4	7	29	25	35	62	45	54	45	39	54	2	3	246
6	5	19	15	22	60	23	54	20	39	34	2	3	247

TABLE XXIV

SIMPLE CORRELATIONS OF GEOMETRY GRADES AND DAT FACTORS WITH CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Geometry	.61	.61	.60	.52	.77	.62
Verbal	.44	.41	.51	.43	.49	.38
Numerical	.46	.50	.44	.46	.39	.45
Abstract	.38	.36	.42	.25	.30	.45
Space	.31	.29	.35	.27	.06	.31
Mechanical	.16	.18	.27	.14	.15	.14
Clerical	.24	.21	.27	.18	.25	.32
Spelling	.32	.32	.32	.28	.53	.31
Sentences	.48	.44	.53	.47	.53	.44
V + N	.50	.50	.53	.50	.51	.46

TABLE XXV

MEANS OF CHEMISTRY GRADES, GEOMETRY GRADES, AND DAT FACTORS FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Chemistry	5.49	5.42	5.60	5.73	4.07	5.61
Geometry	5.77	5.76	5.80	5.84	5.00	5.91
Verbal	26.37	26.99	25.53	27.04	22.04	26.80
Numerical	25.02	25.84	23.90	25.46	22.64	25.19
Abstract	34.87	35.55	33.93	35.63	30.32	35.25
Space	57.38	59.44	54.56	59.43	46.68	58.03
Mechanical	37.39	42.61	30.22	38.49	34.71	36.93
Clerical	56.95	54.16	60.78	57.49	56.93	56.38
Spelling	44.83	40.43	50.89	44.06	40.42	46.82
Sentences	34.77	32.52	37.86	36.42	30.29	34.18
V + N	51.14	52.45	49.34	52.33	44.32	51.67

TABLE XXVI

VARIANCES OF CHEMISTRY GRADES, GEOMETRY GRADES, AND DAT FACTORS FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
Chemistry	3.15	3.29	2.96	2.79	2.96	3.02
Geometry	2.71	2.71	2.75	2.60	3.33	2.54
Verbal	67.34	64.17	71.13	71.49	52.70	62.27
Numerical	51.42	49.66	52.17	55.55	49.35	46.78
Abstract	58.42	42.14	79.91	44.36	138.37	47.68
Space	367.51	373.60	348.75	312.21	422.82	383.78
Mechanical	138.24	106.24	94.00	125.63	149.32	148.06
Clerical	115.63	105.39	105.26	107.70	147.77	117.38
Spelling	574.43	591.91	491.86	589.63	666.11	535.79
Sentences	176.31	154.58	191.33	169.16	165.92	181.31
V + N	191.98	190.32	190.48	202.58	160.52	178.22

TABLE XXVII

MULTIPLE CORRELATIONS INVOLVING COMBINATIONS OF TWO VARIABLES WITH CHEMISTRY GRADES FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

Combinations of Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
2 and 3	.63	.63	.63	.55	.77	.63
2 and 4	.63	.65	.61	.57	.77	.64
2 and 5	.62	.62	.63	.53	.77	.64
2 and 6	.62	.62	.62	.53	.80	.63
2 and 7	.61	.61	.61	.52	.79	.62
2 and 8	.62	.62	.63	.52	.77	.65
2 and 9	.62	.62	.62	.53	.84	.63
2 and 10	.65	.64	.66	.58	.79	.65
2 and 11	.64	.65	.63	.58	.77	.64
3 and 4	.51	.52	.54	.50	.50	.48
3 and 5	.47	.45	.53	.43	.49	.48
3 and 6	.46	.43	.54	.45	.50	.41
3 and 7	.44	.41	.51	.43	.49	.39
3 and 8	.48	.43	.54	.43	.52	.50
3 and 9	.46	.42	.52	.43	.58	.42
3 and 10	.51	.47	.56	.49	.55	.47
3 and 11	.50	.51	.55	.50	.51	.46
4 and 5	.50	.53	.51	.47	.40	.54
4 and 6	.48	.51	.48	.47	.42	.48
4 and 7	.46	.50	.46	.46	.39	.45
4 and 8	.49	.50	.48	.47	.43	.52
4 and 9	.49	.51	.47	.47	.58	.48
4 and 10	.55	.55	.55	.54	.54	.52
4 and 11	.51	.52	.53	.50	.52	.48
5 and 6	.41	.38	.47	.31	.30	.46
5 and 7	.38	.36	.43	.26	.30	.45
5 and 8	.43	.38	.50	.29	.44	.51
5 and 9	.47	.40	.48	.34	.54	.48
5 and 10	.50	.47	.55	.48	.54	.52
5 and 11	.52	.52	.55	.50	.51	.52
6 and 7	.31	.30	.36	.27	.15	.31
6 and 8	.36	.33	.41	.32	.25	.40
6 and 9	.41	.39	.44	.37	.54	.40
6 and 10	.49	.45	.55	.49	.53	.45
6 and 11	.51	.51	.55	.52	.56	.47

TABLE XXVII (continued)

Combinations of Variables	Total	Males	Females	Topeka West	Highland Park	Topeka High
7 and 8	.31	.27	.41	.26	.33	.36
7 and 9	.36	.35	.39	.31	.56	.33
7 and 10	.48	.44	.53	.48	.53	.44
7 and 11	.51	.50	.53	.50	.51	.46
8 and 9	.36	.35	.41	.30	.60	.39
8 and 10	.48	.45	.55	.47	.56	.47
8 and 11	.52	.51	.56	.50	.53	.53
9 and 10	.48	.45	.53	.47	.59	.44
9 and 11	.51	.50	.53	.50	.60	.47
10 and 11	.54	.53	.57	.54	.56	.50

TABLE XXVIII

MULTIPLE REGRESSION EQUATIONS, F RATIOS, STANDARD ERRORS OF ESTIMATE, AND COEFFICIENTS OF DETERMINATION FROM THE CHEMISTRY POPULATION OF THE TOPEKA PUBLIC HIGH SCHOOLS

NOTE: The table should be read as follows: The two independent variables (X_1 and X_2) predict the dependent variable (Y', chemistry grade) in the form $Y' = A + B_1 X_1 + B_2 X_2$; the F, S.E., and R^2 are respectively the F ratio, standard error of estimate, and multiple coefficient of determination.

Variables		Total						Males					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.56	.04	1.28	78.67	1.39	.39	.59	.03	1.01	44.93	1.43	.39
2	4	.54	.05	1.12	80.83	1.38	.40	.53	.07	.61	51.87	1.38	.43
2	5	.59	.03	.91	77.10	1.39	.39	.61	.04	.48	44.80	1.43	.39
2	6	.61	.01	1.37	74.70	1.40	.38	.64	.01	1.27	42.70	1.44	.38
2	7	.66	-.00	1.75	71.45	1.41	.37	.68	-.00	1.60	41.64	1.45	.37
2	8	.63	.02	.73	75.84	1.40	.38	.65	.01	.92	42.64	1.44	.38
2	9	.61	.01	1.53	76.97	1.39	.39	.63	.01	1.44	44.14	1.43	.39
2	10	.53	.03	1.27	87.84	1.36	.42	.57	.03	1.14	48.38	1.40	.41
2	11	.51	.03	1.00	83.82	1.37	.41	.53	.03	.62	50.91	1.39	.42
3	4	.06	.08	2.07	42.87	1.53	.26	.04	.10	1.71	25.76	1.56	.27
3	5	.07	.04	1.97	35.31	1.57	.22	.07	.06	1.49	17.58	1.63	.20
3	6	.08	.01	2.54	33.30	1.58	.21	.08	.01	2.55	15.65	1.65	.18
3	7	.09	-.00	3.00	29.87	1.60	.20	.09	.01	2.63	14.47	1.66	.17
3	8	.09	.03	1.38	36.43	1.56	.23	.09	.03	1.70	16.29	1.64	.43
3	9	.08	.01	2.91	32.33	1.59	.21	.08	.01	2.98	14.99	1.66	.18
3	10	.05	.04	2.64	42.79	1.53	.26	.05	.04	2.64	20.15	1.61	.22
3	11	-.01	.07	2.19	41.71	1.54	.25	-.04	.09	1.94	24.70	1.57	.26
4	5	.09	.05	1.42	41.45	1.54	.25	.11	.05	.73	26.89	1.55	.28
4	6	.10	.01	2.21	36.75	1.56	.23	.12	.01	1.73	24.64	1.57	.26
4	7	.11	.00	2.54	33.14	1.58	.46	.12	.02	1.59	23.83	1.58	.50
4	8	.11	.03	1.30	38.16	1.55	.24	.12	.01	1.50	23.69	1.58	.25
4	9	.10	.01	2.50	37.68	1.56	.24	.11	.01	2.13	24.13	1.57	.26
4	10	.07	.04	2.09	51.56	1.49	.30	.10	.04	1.71	30.00	1.53	.30
4	11	.03	.05	2.12	42.45	1.53	.26	.06	.04	1.73	26.16	1.56	.27

TABLE XXVIII (continued)

Variables		Total						Males					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
5	6	.07	.01	2.18	23.97	1.63	.16	.08	.01	1.80	11.83	1.69	.14
5	7	.09	.00	2.41	20.08	1.65	.14	.09	.01	1.62	10.57	1.70	.13
5	8	.08	.03	.60	27.78	1.61	.19	.09	.02	.86	11.96	1.69	.15
5	9	.07	.02	2.24	28.65	1.60	.19	.08	.02	2.10	13.55	1.67	.16
5	10	.04	.05	2.23	41.15	1.54	.25	.05	.05	1.90	19.87	1.61	.22
5	11	.04	.05	1.49	45.36	1.52	.27	.04	.06	1.01	25.97	1.56	.27
6	7	.03	.00	3.80	12.72	1.69	.09	.02	.01	3.45	6.96	1.74	.09
6	8	.03	.03	2.15	18.69	1.66	.13	.02	.03	2.43	8.77	1.72	.11
6	9	.02	.02	3.17	25.22	1.62	.17	.02	.02	3.30	12.77	1.68	.15
6	10	.01	.06	2.78	39.46	1.55	.24	.01	.06	2.96	17.93	1.63	.20
6	11	.01	.06	1.98	43.15	1.53	.26	.01	.06	1.80	24.20	1.57	.26
7	8	.03	.05	1.80	13.13	1.69	.10	.03	.04	2.25	5.51	1.76	.27
7	9	.02	.02	3.53	18.16	1.66	.13	.03	.02	3.45	9.67	1.71	.12
7	10	.01	.06	2.98	36.66	1.56	.23	.01	.06	3.16	16.96	1.64	.20
7	11	-.01	.07	2.31	41.89	1.54	.26	.00	.07	1.82	23.82	1.58	.25
8	9	.03	.02	2.92	18.70	1.66	.13	.02	.02	3.23	9.51	1.71	.12
8	10	.02	.06	2.56	37.39	1.56	.23	.01	.06	2.79	17.33	1.63	.20
8	11	.03	.06	.93	46.80	1.51	.28	.02	.06	1.25	24.72	1.57	.26
9	10	.00	.06	3.25	36.25	1.56	.23	.01	.06	3.31	17.41	1.63	.20
9	11	.01	.06	2.20	42.84	1.53	.26	.00	.06	1.97	23.80	1.58	.25
10	11	.03	.04	2.07	51.03	1.50	.29	.03	.05	1.87	27.01	1.55	.28

Variables		Females						Topeka West					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.49	.05	1.54	34.07	1.34	.40	.42	.04	2.10	24.10	1.40	.30
2	4	.55	.03	1.66	30.60	1.37	.38	.40	.06	1.82	26.83	1.38	.33
2	5	.54	.04	1.28	32.45	1.36	.39	.50	.02	1.90	21.13	1.43	.28
2	6	.57	.02	1.46	32.21	1.36	.39	.50	.01	2.10	21.85	1.42	.28
2	7	.60	.01	1.74	29.54	1.38	.37	.53	.01	2.43	20.34	1.44	.27
2	8	.60	.03	.45	32.52	1.36	.40	.52	.01	1.99	20.79	1.43	.27
2	9	.58	.01	1.66	31.59	1.36	.38	.49	.01	2.46	21.74	1.43	.28
2	10	.47	.04	1.43	38.76	1.31	.43	.39	.04	2.06	27.91	1.37	.34
2	11	.47	.03	1.41	33.47	1.35	.40	.36	.04	1.75	27.51	1.38	.33
3	4	.08	.05	2.32	20.78	1.46	.29	.05	.07	2.58	18.62	1.46	.25

TABLE XXVIII (continued)

Variables:		Females						Topeka West					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
3	5	.08	.04	2.22	20.03	1.47	.28	.08	.02	2.99	12.53	1.52	.19
3	6	.09	.02	2.32	20.59	1.46	.29	.07	.02	2.79	14.30	1.50	.21
3	7	.10	.01	2.82	17.48	1.50	.26	.08	.00	3.37	12.23	1.52	.18
3	8	.10	.03	1.09	21.01	1.46	.29	.08	.01	2.82	12.69	1.52	.19
3	9	.09	.01	2.77	18.39	1.49	.27	.08	.00	3.46	12.36	1.52	.18
3	10	.05	.04	2.64	22.74	1.44	.31	.04	.04	3.09	17.84	1.46	.24
3	11	.03	.05	2.39	20.10	1.47	.28	-.02	.07	2.65	18.52	1.46	.25
4	5	.08	.06	1.92	17.84	1.49	.26	.10	.02	2.43	15.58	1.49	.22
4	6	.09	.02	2.52	15.03	1.53	.23	.09	.01	2.73	15.75	1.48	.22
4	7	.09	.02	2.67	13.22	1.55	.21	.10	.00	3.06	14.82	1.49	.21
4	8	.10	.03	1.25	15.27	1.52	.23	.10	.01	2.46	15.37	1.49	.22
4	9	.09	.01	2.81	14.13	1.54	.22	.09	.01	3.05	15.51	1.49	.22
4	10	.05	.05	2.51	22.22	1.45	.31	.07	.04	2.45	23.18	1.41	.30
4	11	-.02	.07	2.37	19.73	1.47	.28	.02	.05	2.62	18.61	1.46	.25
5	6	.07	.02	2.31	14.07	1.54	.22	.04	.02	3.06	6.04	1.60	.31
5	7	.07	.02	2.56	11.77	1.57	.19	.06	.01	3.33	3.87	1.63	.07
5	8	.08	.04	.12	16.94	1.50	.25	.06	.02	2.22	5.17	1.61	.09
5	9	.07	.02	2.27	15.22	1.52	.23	.05	.02	3.29	7.05	1.59	.11
5	10	.03	.05	2.44	21.51	1.46	.30	.02	.06	3.07	16.16	1.48	.23
5	11	.04	.05	1.78	21.96	1.45	.30	.01	.06	2.49	18.38	1.46	.25
6	7	.03	.02	3.50	7.69	1.62	.13	.02	.00	4.13	4.44	1.62	.07
6	8	.03	.04	1.87	9.96	1.59	.16	.03	.03	2.70	6.27	1.60	.10
6	9	.03	.02	2.95	12.37	1.56	.20	.02	.02	3.63	8.58	1.57	.13
6	10	.02	.06	2.53	22.18	1.45	.31	.01	.06	2.97	17.35	1.47	.24
6	11	.01	.06	1.96	21.59	1.45	.30	.01	.05	2.34	19.15	1.45	.26
7	8	.05	.05	.86	9.91	1.59	.16	.03	.04	2.64	3.83	1.63	.07
7	9	.04	.02	3.22	9.32	1.60	.16	.02	.02	4.07	5.98	1.60	.10
7	10	.01	.06	2.84	19.94	1.47	.28	.01	.06	3.07	16.52	1.48	.23
7	11	.01	.06	2.26	19.70	1.47	.28	-.00	.06	2.77	18.37	1.46	.25
8	9	.04	.02	1.82	10.15	1.59	.17	.02	.02	3.92	5.45	1.61	.09
8	10	.03	.06	1.64	21.92	1.45	.30	.00	.06	3.30	1 .91	1.48	.22
8	11	.03	.06	.73	22.74	1.44	.31	.01	.06	2.28	18.55	1.46	.25

TABLE XXVIII (continued)

Variables		Females						Topeka West					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
9	10	.00	.06	3.08	19.50	1.48	.28	-.00	.06	3.53	15.85	1.48	.22
9	11	.01	.06	2.25	20.23	1.47	.29	-.00	.06	2.67	18.31	1.46	.25
10	11	.04	.04	2.28	23.94	1.43	.32	.03	.04	2.49	22.25	1.42	.29

Variables		Highland Park						Topeka High					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
2	3	.67	.02	.20	18.33	1.14	.59	.62	.02	1.32	33.73	1.36	.40
2	4	.79	-.03	.80	18.58	1.13	.60	.58	.04	1.07	35.80	1.35	.41
2	5	.73	-.00	.51	17.85	1.15	.59	.57	.05	.52	36.54	1.34	.42
2	6	.80	-.02	.99	22.04	1.08	.64	.64	.01	1.29	34.04	1.36	.40
2	7	.80	-.03	1.05	20.46	1.10	.62	.69	-.01	1.77	32.84	1.37	.39
2	8	.70	.01	- .24	18.53	1.13	.60	.63	.03	.12	37.78	1.33	.42
2	9	.64	.02	- .07	30.23	.97	.71	.64	.01	1.47	33.95	1.36	.40
2	10	.63	.03	.11	20.32	1.10	.62	.58	.03	1.25	37.92	1.33	.42
2	11	.71	.00	.39	17.85	1.15	.59	.58	.02	1.02	35.76	1.35	.41
3	4	.09	.04	1.18	4.17	1.55	.25	.04	.09	2.28	15.40	1.54	.23
3	5	.12	-.00	1.57	3.88	1.56	.24	.04	.09	1.40	15.51	1.54	.23
3	6	.13	-.01	1.79	4.16	1.55	.25	.07	.01	3.03	10.14	1.60	.16
3	7	.12	-.01	1.72	3.96	1.56	.24	.09	-.01	3.44	9.02	1.62	.15
3	8	.11	.03	.24	4.56	1.53	.27	.08	.05	.52	16.82	1.52	.25
3	9	.07	.03	1.57	6.42	1.45	.34	.07	.01	3.17	10.73	1.60	.17
3	10	.05	.05	1.47	5.37	1.49	.30	.04	.04	3.00	14.47	1.55	.22
3	11	.03	.05	1.03	4.50	1.53	.26	-.02	.07	2.55	13.60	1.56	.21
4	5	.08	.02	1.72	2.43	1.64	.16	.08	.08	.79	20.74	1.48	.29
4	6	.12	-.02	2.13	2.64	1.62	.17	.10	.02	2.17	15.82	1.53	.23
4	7	.09	.01	1.79	2.21	1.65	.15	.12	.00	2.70	13.44	1.56	.21
4	8	.09	.03	.62	2.78	1.62	.18	.11	.04	.58	19.34	1.50	.27
4	9	.06	.03	1.45	6.43	1.45	.34	.10	.01	2.54	15.16	1.54	.23
4	10	.03	.06	1.51	5.17	1.50	.29	.08	.04	2.27	19.40	1.50	.27
4	11	-.06	.10	1.07	4.75	1.52	.28	.06	.03	2.34	15.11	1.54	.23
5	6	.05	-.00	2.85	1.27	1.70	.09	.10	.01	1.55	13.86	1.56	.21
5	7	.05	-.00	2.77	1.25	1.70	.09	.12	-.00	1.65	13.33	1.56	.21

TABLE XXVIII (continued)

Variables		Highland Park						Topeka High					
X_1	X_2	B_1	B_2	A	F	S.E.	R^2	B_1	B_2	A	F	S.E.	R^2
5	8	.05	.05	- .29	3.05	1.60	.20	.10	.04	-.09	17.85	1.51	.26
5	9	.02	.03	2.26	5.19	1.50	.29	.10	.01	1.47	15.76	1.54	.23
5	10	-.03	.09	2.19	5.25	1.50	.30	.08	.04	1.59	18.67	1.50	.27
5	11	-.01	.08	1.03	4.46	1.53	.26	.07	.04	1.03	18.73	1.50	.27
6	7	-.00	.02	3.35	.28	1.77	.02	.03	-.00	4.03	5.53	1.67	.10
6	8	.00	.03	2.03	.82	1.73	.06	.02	.04	1.96	9.89	1.61	.16
6	9	.00	.04	2.38	5.03	1.51	.29	.02	.02	3.41	9.55	1.61	.16
6	10	-.00	.07	2.07	4.95	1.51	.28	.01	.05	3.26	13.42	1.56	.21
6	11	-.02	.09	1.22	5.75	1.48	.32	.01	.05	2.35	14.23	1.55	.22
7	8	.03	.04	.60	1.49	1.69	.11	.02	.05	1.69	7.66	1.64	.13
7	9	.02	.04	1.84	5.58	1.49	.31	.02	.02	3.83	6.50	1.65	.11
7	10	-.01	.07	2.13	4.98	1.51	.28	.01	.06	3.49	12.40	1.58	.19
7	11	-.01	.07	1.13	4.46	1.53	.26	-.01	.06	2.70	13.70	1.56	.21
8	9	.04	.04	.44	6.89	1.43	.36	.04	.02	2.56	9.05	1.62	.15
8	10	.03	.07	.49	5.80	1.48	.32	.03	.05	2.45	14.22	1.55	.22
8	11	.02	.07	-.05	4.94	1.51	.28	.04	.06	.20	20.42	1.48	.28
9	10	.02	.04	1.89	6.56	1.45	.34	.00	.05	3.62	12.47	1.57	.19
9	11	.02	.04	1.15	6.98	1.43	.36	.01	.05	2.50	14.47	1.55	.22
10	11	.05	.03	1.17	5.60	1.49	.31	.03	.04	2.43	17.37	1.52	.25

GEOMETRY GRADES: A PREDICTOR OF ACHIEVEMENT IN PHYSICS AND CHEMISTRY IN TOPEKA PUBLIC SCHOOLS, TOPEKA, KANSAS

by

ROGER LEE DIRKS

B. S., Bethany College, 1963

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

It was the purpose of this study to determine whether a geometry grade was a good predictor of achievement in physics and chemistry in the Topeka Public High Schools, Topeka, Kansas. Correlations were established by using grades and scores from the Differential Aptitude Test (DAT) as variables. Eventually, multiple regression equations were determined as instruments to predict physics achievement and chemistry achievement by using a combination of variables.

Two different populations were used. These were selected from the 1965 senior class of the three Topeka Public High Schools. One group, called the physics population, was determined by all students who had taken physics, geometry, and the DAT. The other group, called the chemistry population, was determined by all students who had taken chemistry, geometry, and the DAT.

The data were collected from the student records and analysed at the Computer Center at Kansas State University, Manhattan, Kansas. The basic program for the IBM 1410 computer was a multiple regression analysis.

It was found that there was a substantial positive correlation (.68) between geometry grades and physics grades. A higher multiple correlation (.77) was obtained by using the geometry grades and the verbal plus numerical (V + N) factors of the DAT. This led to a regression equation for predicting a physics grade (Y'). This equation was $Y' = -1.36 + .52X_1 + .05X_2$, where X_1 and X_2 represented respectively the geometry and V + N variables.

The second part of the study, involving the chemistry population, indicated there was a substantial positive correlation (.61) between geometry grades and chemistry grades. A slightly higher multiple correlation (.65) was obtained with the geometry grades and the sentences factors of the DAT. This led to a regression equation for predicting a chemistry grade (Y'). This equation was $Y'' = 1.27 + .53X_1 + .03X_2$, where X_1 and X_2 represented respectively the geometry and sentences variables.