AN EVALUATION OF CERTAIN MEASURES OF APTITUDE AND ACHIEVEMENT IN THE PREDICTION OF SCHOLASTIC SUCCESS

By

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AN ABSTRACT

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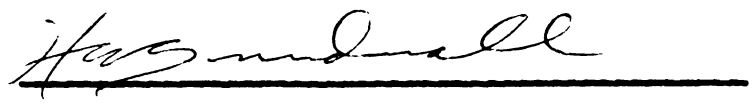
Approved 

PROBLEM. The problem of this study was to investigate the single and combined value of seven aptitude and achievement tests in predicting general high school academic success, as well as success in eight high school subject areas, i.e. English, social studies, science, mathematics, industrial arts, home economics, business education and foreign language.

PREDICTOR TESTS AND CRITERIA. The predictor tests included the following: (1) two measures of achievement, the Mathematics Proficiency and the English Proficiency Tests, (2) four "special" aptitude measures taken from the Differential Aptitude Battery, i.e. Verbal Reasoning, Numerical Ability, Mechanical Reasoning, and Language Usage, and (3) a general scholastic aptitude test, the Terman-McNemar Test of Mental Ability.

Two criteria for scholastic success in subject areas were used. They were grade point averages and the four subject area measures of the Essential High School Content Battery. Grade point averages were computed by averaging the final course marks in at least three courses within a subject area. Composite scores of these two measures served as criteria for general scholastic success.

Whereas the predictor tests were administered while the students were in the eighth grade, the criterion measures were secured at least three years later. Thus, the test validity established in this study is of the predictive type.

SUBJECTS. Six senior high schools in the Cincinnati Public School system were originally surveyed. Three of these six schools were finally singled out for further study because of their uniform marking

practices. The three schools used were identified through the use of an analysis of covariance of grade point averages adjusted for mean school levels of scholastic ability. The subjects thus derived consisted of a total of 595 senior students made up of 266 boys and 329 girls. Only students for whom complete test records were available were included in this study.

METHODS AND PROCEDURES. The relationships between the predictor tests and the criteria were established by Pearson product-moment correlations. The methods of multiple correlation and regression were used to ascertain the combined predictive power of the test predictors. The significance of difference between mean predictor test performance of various sub-groups was tested by means of Student's "t" ratio.

FINDINGS. The general findings of this study may be enumerated as follows:

1. The Mathematics Proficiency Test proved to be the best predictor of total grade point average for boys and girls; the zero order correlations being .657 and .716, respectively. The Terman-McNemar Test correlated highest with the composite scores of the EHSCB for both boys and girls; the correlations were .803 and .858, respectively.

2. On the whole, the Mathematics Proficiency Test and the Terman-McNemar Test showed the highest correlations with grade point averages in various subject areas. The correlations ranged from .364 to .690. The Terman-McNemar was, in general, the best predictor of the EHSCB sub-tests. The correlations ranged from .674 to .818.

3. Although many differences proved to be non-significant, girls were a more predictable group than boys in terms of the criteria and

predictors used.

4. Since verbal tests correlated more highly than "number" tests with the EHSCB criteria, and the "number" tests correlated more highly with grade point averages, it seems evident the differences in these two types of criteria lie in the different aspects of "intelligence" measured by them.

5. There were no statistically significant differences in the multiple correlations derived from the best combination of two predictors and a combination of all eight predictors.

6. On the whole, the best predictor tests in one subject area were found to be the best predictors in other subject areas. Therefore, the existence of special abilities, which would be needed for determining choice of subject area majors, did not seem to differentiate subject area groups.

7. The mean predictor test differences between those students majoring in any one subject area and those not majoring in that area were statistically significant in eighty-four out of eighty-eight cases. These differences are likely accounted for by the different combinations of subject area majors which the more and less capable students tend to elect.

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CHAPTER I

FORMULATION AND DEFINITION OF THE PROBLEM

I. INTRODUCTION

In the Cincinnati Public Schools, group testing is the responsibility of the Division of Appraisal Services. This Division gives over one hundred thousand tests yearly in an attempt to evaluate pupils for various purposes. Among the tests given each year as a part of the regular testing program are tests of achievement and intelligence. Periodically, however, other tests are given on an experimental basis to determine their value for specific purposes. All intelligence tests given by this Division are administered by trained examiners whose sole function is test administration. Test score variability due to variations in test administration are, therefore, minimal.

One of the many reasons for administering a testing program is to evaluate pupil performance at a given time in order to provide data that will make it possible to predict performance in future situations. In the Cincinnati Public Schools, curricular, administrative, and instructional decisions are often based on information of this kind. It is, therefore, imperative that the instruments used actually do the job they are intended to do. This aspect of a test is called validity; when the test is called on to predict future performance, it must have predictive validity.

The administrators of a testing program constantly face the problem of selecting the particular tests which will provide best the

information they are seeking. Many tests may possess a degree of validity for specific purposes, but few, if any, possess validity which can be applied in a variety of situations. The problem of the test administrator is to determine which tests perform the prescribed function best. This problem is encountered not only in the selection of new tests, but also in terms of re-evaluating the testing instruments which are in current use in the testing program. This re-evaluation or confirmation of validity must be done periodically because often the characteristics of a (test) population may alter significantly. Consequently, a test that may have been valid for a past population may be rather ineffective in accomplishing its function on a different population. It is not sufficient to make armchair speculations concerning the predictive validity of tests; nor can one fully accept validity as it is demonstrated in test manuals, since validity is highly specific to the population on whom it was originally obtained. Test administrators are committed, therefore, to experimentally determining the validity of a test before incorporating it into the testing program itself.

During the school year 1952-53, the current senior class (1956-57) in all six of Cincinnati's high schools was given the Terman-McNemar Test of Mental Ability and an English and Mathematics Proficiency Test as a regular part of the Division's testing program. In addition, when in the eighth grade, this group also was given four subtests of the Differential Aptitude Battery, i.e. Verbal Reasoning, Numerical Ability, Mechanical Reasoning, and Language Usage, for determining experimentally their value in the Division's testing program. These specific subtests were used because a review of other studies and

some past experience has shown these subtests to be of greatest value for the purpose for which they were to be used, i.e. the prediction of academic achievement. Using these Differential Aptitude Tests together with the Terman-McNemar Test of Mental Ability, and the English and Mathematics Proficiency Tests, an attempt was made to predict the achievement of pupils at the high school level.

The junior high school pupil anticipating his entrance into a senior high school has many decisions to make concerning his educational future. With the growing complexities in curricula, one of the fundamental decisions he must make is what subjects shall be his area of concentration. It is the responsibility of the school to provide educational information to students in an attempt to aid them in making suitable educational plans at the high school level.

To define what is meant by "suitable educational plans," is indeed a difficult task. It is a problem with many facets, each requiring its own analysis and evaluation. Most of these facets, do, necessarily, require subjective analysis and interpretation since they deal with attitudes, values, home environment, personality factors, etc. Among the most significant objective areas of evaluation, however, are those derived from standardized tests.

II. GENERAL PURPOSE AND STATEMENT OF THE PROBLEM

General purpose. If the premise is accepted that one of the more important aspects of suitable educational planning is the student's attainment of scholastic success in whatever subject-matter area he chooses (relative to his capabilities), it would be agreed that the

prediction of student performance on standardized tests would be helpful in educational planning.

With this premise in mind, the general purpose of this study is to evaluate certain aptitude and achievement tests. The resulting educational information then will be used to aid junior high school counselors in helping students to select high school majors in subject areas in which they are likely to achieve success.

Statement of the problem. The problem of this study is to evaluate singly, and in combination, the ability of seven measures of aptitude and achievement to predict academic success in eight subject areas at the high school level, i.e. English, social studies, science, mathematics, foreign language, industrial arts, home economics, and business education, in addition to predicting the general academic success of high school students.

III. THE SIGNIFICANCE OF THE STUDY

The significance of this study rests primarily on an attempt to overcome certain limitations of similar studies conducted previously and to determine the predictive validity of the instruments used on a particular population in the Cincinnati Public Schools.

Although many studies have been conducted in an attempt to predict academic success at the high school level, most of these studies are of limited value in situations outside the one in which the study was conducted. It is difficult and often dangerous to generalize regarding the results of any study of this type to other school systems (and even schools within a given system unless one can demonstrate the

comparability of the schools involved) because of the differences that may exist in the characteristics of the population. Each school is unique. There are varying emphases in the curricula, different methods of teaching, different personnel and course content, and, of course, varying abilities of the student population itself. These differences emphasize the lack of general validity of an instrument and the need for specific validity. In discussing the use of tests in guidance, McDaniel states, "Test meanings are culture centered, temporal, and situational. Test data reported in a manual apply, within limits, to the time, place, and sample studied."[1]

Many earlier prediction studies have dealt with prediction in a specific subject; thus, the degree of prediction and relatedness of the criterion and predictor in that subject area could not be compared with others using the same predictors. This study is designed to make such comparisons possible.

Authors of many predictinn studies have secured criterion measures only for the period in which the predictors were used. The resulting data collected for the purpose of prognosis may thus be considered concurrent validity and not predictive validity. In its Technical Recommendations for Achievement Tests, the Committee on Test Standards for the AERA and NCMUE states:

> The former (concurrent validity) answers the question, "With what degree of accuracy can the test scores replace the scores on an existing criterion?" the latter (predictive validity) answers the

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[1]H.B. McDaniel, "The Use of Tests in Guidance," California Guidance Newsletter, 3:3, November, 1949.

question, "With what degree of accuracy can the test scores estimate the scores on the criterion that the test subjects would achieve sometime later?[2]

In those studies in which predictive measures have been secured prior to the criterion measures, the length of time intervening has often been too short; thus, long range prediction cannot be inferred safely, and the usefulness of such prediction is of limited value. Furthermore, the number of cases in the sample used is often insufficient for a valid conclusion. In this study, the predictors were administered from three to three and one-fourth years before the criterion measures were secured, and the total sample included 595 students.

Because of the changes occurring within any given school system, i.e. changes in curriculum, physical facilities, teaching personnel, student population, etc., it is necessary to periodically re-check the effectiveness of prediction in the given situation. As previously stated, this is one of the purposes for conducting this study.

In reviewing prediction studies of academic success, it was noticed also that few studies report differential prediction between the sexes, even though sex differences in learning show that boys and girls acquire knowledge and skills selectively.[3] If these differences are ignored, it may lead to erroneous conclusions in interpretation. Furthermore, the estimation of variance of test scores among high

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[2]Committee on Test Standards for the AERA and NCMUE, Technical Recommendations for Achievement Tests (Washington, D.C.: National Education Association, 1955), p.17.

[3]Alexander G. Wesman, "Separation of Sex Groups in Test Reporting," Journal of Educational Psychology, 40:223, April, 1949.

school students shows sex differences, the girls being a more variable group due to their generally lower dropout rate.[4] Combining groups, therefore, would result in spurious measures of relationship.

Due to differences in grading practices among schools, the comparability of schools should be demonstrated before combining students from different schools into a single sample for study. When this is not done, it is impossible to know whether the criterion measures have the same significance or meaning. For example, it would not be known whether an "A" in one school indicates the same standard as an "A" from another school.

In this study, through the use of an analysis of covariance technique, comparable schools were identified and selected. Finally, one of the more significant aspects of this study is an attempt at multiple prediction of the criterion, using intelligence, achievement and aptitude tests as combined predictors. In so doing, a relative ranking of the predictors results. From this one can select the best predictors and determine which combination has the relatively highest predictive power.

IV. SCOPE AND LIMITATIONS OF THE STUDY

The sample studied was drawn from the twelfth grade classes of three Cincinnati Public High Schools. As such, generalizations resulting from this study must be limited to this student population.

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[4]Clifford P. Archer, "Student Mortality," Encyclopedia of Educational Research (New York: The Macmillan Company, 1950), p.1158.

Since only those students for whom complete test records were available were included in this study, another element of selectivity is present. The degree to which this selectivity has affected the representativeness of the population is not known.

Other limitations which may or may not prevail are those concerned with the tenability of certain assumptions which are required for certain statistical tests and analyses. For purposes of correlation analyses, for example, assumptions regarding the linearity of regression are made. In addition, the assumption of homoscedasticity is made. Normal distributions of the traits being measured also are assumed.

Other limitations are those associated with methodology and the instruments used. Limitations lie in the selection of the sample, its number, and its cross-sectional nature. Although the validity of the tests used in this study is the problem under scrutiny, the reliability of the instruments place limitations on their usefulness as predictors of academic success.

One of the severest limitations of this study has to do with the questionable validity of grade point averages and achievement test scores as measures of scholastic success. For purposes of this study, it is necessary to define scholastic success operationally in terms of the criteria used.

V. STATEMENT OF OBJECTIVES AND HYPOTHESES

Objectives. In an attempt to pursue the general purpose and problem of this study, the specific objectives represent an attempt to answer the following questions:

1. Which of the aptitude and achievement measures in this study correlates highest with general academic success as measured by total grade point average and the composite score of the Essential High School Content Battery?

2. Which of the aptitude and achievement tests correlates highest with scholastic success in each of eight subject areas as measured by grade point averages in these subject areas and the areas measured by the Essential High School Content Battery?

3. Are there sex differences in terms of predicting the criteria used as measures of scholastic success?

4. In terms of their relation to the aptitude and achievement predictor variables, what are the differences between the grade point average and the Essential High School Content Battery criteria?

5. Are there significant differences in predicting grade point averages between the multiple correlations derived from a combination of all predictor variables and those derived through a combination of two of these predictors?

6. With a knowledge of the individual predictor test correlations with the grade point average criteria, is it possible to isolate certain abilities which are needed for success in a given subject area?

7. Are there significant differences in performance on the aptitude and achievement predictors between those students majoring in any one subject area and those who are not majoring in that subject area?

In addition, and perhaps most important, it is an objective of this study to aid counselors in using the educational information

obtained from this study. Too often, the findings of educational research are merely a matter of academic interest and do not result in action. Probably such information is used infrequently because studies of this type generally result in correlation coefficients indicating the degree to which prediction can be made. Computing the correlation coefficient may be a necessary step, but too often it has the peculiar quality of being meaningless, misunderstood, or misused, even among those who use tests frequently.

An objective of this study, therefore, is to aid junior high school counselors, who may wish to utilize the information secured in this study, in interpreting the phenomenon of regression through the use of nomographs. These nomographs will indicate the best prediction of the criterion through its regression on the predictor variables, in the form of an easily understood, graphical presentation.

Hypotheses. Assuming that academic achievement is due largely to a generalized verbal factor, and assuming further that the Terman-McNemar Intelligence Test is a valid measure of this verbal factor, it is hypothesized that this test will be the best all-around predictor of academic success. It is likely that in the process of averaging marks from different subjects within a subject area, the existence of special abilities would be obscured and in their place would emerge an aspect of the "general" intelligence factor.

This general factor, however, is likely to play a more important role in the prediction of the Essential High School Content Battery criteria, since the latter criteria are probably more dependent upon verbal skills than are the characteristics upon which school marks are

based.

Since twelfth grade girls probably represent a more heterogeneous population than do twelfth grade boys, it would be expected that the aptitude and achievement predictors would correlate higher with both criteria for girls than they would for boys.

Due to the more highly verbal nature of the Essential High School Content Battery criteria over the grade point average criteria it would be expected that much of the difference between these two criteria would be in terms of the degrees to which the verbally loaded measures differentially correlate with them.

Boys would be expected to perform higher on the "number" tests, the Mechanical Reasoning and the Terman-McNemar intelligence test, while girls probably would exceed boys on the Spelling, Sentences, English Proficiency, and Verbal Reasoning tests. This hypothesis is based on the findings of numerous studies showing that on the whole, boys exceed girls on quantitative measures while girls generally exceed boys on linguistic measures. Even though the Terman-McNemar Test is verbally oriented, it is nevertheless, a general aptitude test, and since it is expected that the remaining twelfth grade boys represent a more homogeneous and academically select group than do girls it, therefore, would be expected that they would perform higher on this test.

Finally, it is hypothesized that there will be significant differences in mean performance on the aptitude and achievement predictors when students majoring in a subject area are compared to those not majoring in that subject area. This hypothesis results from the notion that on the whole, the brighter students tend to enter the college

preparatory curriculum, i.e. mathematics, science, and foreign language, while the less capable students tend to select other subject areas for majors.

VI. DEFINITIONS OF TERMS USED

Subject-matter area or subject area. A group of subjects or courses which, by virtue of their content, are similar. Examples of subject areas are science, mathematics, English, etc.

Subject or course. These refer to the entities which make up subject areas. Examples of subjects are biology, physics, algebra, etc.

Marks. Marks are teachers' ratings of a student's performance in a subject. The terms "marks" and "grades" are used interchangeably.

Total grade point average. This represents an arithmetic mean of all marks given in full-year subjects during the student's four years of high school. It does not include courses such as physical education or health.

Grade point average. This represents the arithmetic mean of three or more marks given within a subject area in three or more full-year subjects.

Major. A major consists of three or more subjects taken within a subject area. The students in this study are required to complete three majors for high school graduation.

Criteria. In this study, the measures used as standards of scholastic success are grade point averages and an achievement test, the Essential High School Content Battery.

Predictor test (variables). These refer to the seven aptitude and

achievement tests administered to the pupils in eighth grade for purposes of predicting academic success in high school.

Scholastic or academic success. This expression is defined operationally in terms of the degree to which a student attains high scores on the two criteria used in this study.

VII. ORGANIZATION OF THE STUDY

In Chapter II an attempt is made to review pertinent studies relating to the prediction of general scholastic success through the use of "non-intellectual" and "intellectual" variables. Secondly, Chapter II contains a review of studies relating to the prediction of scholastic success in particular subject areas using instruments such as aptitude batteries, general scholastic aptitude tests, and achievement tests as predictors of success. Chapter III provides an explanation of the criteria and sources of data including a review of tests used. The methods and procedures used in this study will be discussed in Chapter IV. Chapters V and VI present the findings and analysis of the prediction of general academic success and subject area academic success, respectively. Chapter VII contains the summary, conclusions, and implications for further research.

CHAPTER II

REVIEW OF THE LITERATURE

In reviewing rhe literature pertaining to the prediction of high school academic success, one is impressed with the tremendous amount of effort put forth in its prediction, at least in terms of the number of investigations carried out. The greatest bulk of these studies seem to have been carried out between 1920 and 1940 with a drop off in the past fifteen years. Perhaps the incidence of prediction studies dealing with academic success is on the upswing with the relatively recent appearance of well constructed multiple aptitude test batteries.

Practically all the prediction studies reviewed used the Pearson product-moment correlation coefficient as the index of relationship between the predictor used and the criterion. As for the criteria used, the school grade and the results of standardized achievement tests stand far ahead in use. Indeed, one is hard pressed to find other criteria as easily available and more generally accepted as these.

The literature contains studies which run the gamut of subject-matter performance to be predicted. However, one topic which has received much attention is the prediction of general academic success. Two approaches may be identified; one approach dealing with "intellectual" factors as predictors, and another dealing with "non-intellectual" factors as predictors. These two approaches, in the prediction of general academic success, will be dealt with in the first section of this chapter.

The second section of this chapter will attempt to review those

investigations dealing with the prediction of success in specific subject areas. In the latter section, an attempt will be made to review studies which have utilized achievement tests and general and special aptitude tests including some of the well known batteries. This section will be followed by a summary of Chapter II.

I. THE PREDICTION OF GENERAL ACADEMIC SUCCESS

Non-intellectual factors. It is a well known fact that no matter how reliable and valid a general intelligence test may be, it does not account for all the variation in academic achievement. In an effort to account for this variation, investigators have naturally turned their attentions to the so called "non-intellectual"factors of personality.

In isolating some of the personality factors which relate to achievement, Ames[1] used a thirteen item personality rating scale. The subjects were 230 students constituting a graduating class in a mid-western high school. The procedure was to have each student evaluated on the personality scale by each teacher having the student in class at the time of the study. The personality factors purportedly measured by the rating scale were; sociability, attractiveness, nervousness, popularity, punctuality, courtesy, cooperation, persistence, honesty, common sense, sincerity, dependability, and general attitude toward school. In addition, the Otis Intelligence scores were available having been administered to the subjects during their 9-B grade level. The criterion for

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[1] Viola Ames, "Factors Related to High School Achievement," Journal of Educational Psychology, 34:229-236, April, 1943.

scholastic success was the four year high school average of all grades received. Direct correlations with the criterion showed sociability, attractiveness, and popularity to show no significant relationship. Persistence, common sense, and dependability correlated .60, .52, and .57, respectively, with the criterion. Other correlations with the criterion were as follows: punctuality, .47; cooperation, .45; honesty, .41; sincerity, .49; nervousness, .28; courtesy, .32; and general atitude toward school, .57. None of these thirteen traits correlated highly with the Otis. The multiple correlation derived using a combination of these traits with the Otis was .72. The correlation between the Otis and the average grade criterion was .54. By using the factor analysis technique, it was found the total of fifteen variables measured two factors; ability to succeed socially and ability to conform to school situations. It was concluded also that social success was not related to scholastic achievement, but that the ability to conform to school situations was related to scholastic achievement.

This study certainly demonstrated the importance of this type of approach, however, it is questionable whether the latter study could be described as predictive in nature. The teachers who rated the subjects did so when the subjects were in their twelfth grade and in the teachers' classes. It is very likely, therefore, that the ratings were influenced by the past achievement of the subjects. The study may describe, however, the traits upon which teachers base the grades they give.

The use of non-intellectual factors as predictive measures of success would naturally lead investigators to the use of standardized personality tests as well as other instruments. One such study was

carried out by Gough.[2]

Gough selected two criterion samples of twenty-seven each from a total group of 231 high school seniors. Pairs were matched on the basis of Otis I.Q. and sex and then split according to their three year high school honor point ratio (HPR). The two groups were then compared in performance on the Minnesota Multaphasic Personality Inventory, the Security-Insecurity Inventory, the Otis and Pintner intelligence tests, and socio-economic status as measured by the Sims Score Cards. The resulting analyses revealed that none of these variables showed a statistically significant difference between the two groups.

Through an item analysis of the Minnesota Multaphasic Personality Inventory, a group of items found to differentiate achievers (called the Ac Scale) was found to correlate .43 with three year HPR. The correlation between the Otis Intelligence Test and HPR was .62. Other variables were also included in an attempt to predict HPR. Correlations of the various scales of the MMPI ranged from .35 to -.21. The Sims Score Cards showed a correlation of .25 with HPR. The Cooperative English Test correlated .72 with HPR. The highest degree of multiple correlation using non-intellectual factors was .54. This consisted of a combination of the Ac Scale and the St (Status) Scale of the MMPI.

Another study which attempted to relate high school achievement with personality variables as measured by a standardized test is

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[2]Harrison G. Gough, "Factors Relating to the Academic Achievement of High School Students," Journal of Educational Psychology, 40:65-78, February, 1949.

reported by Hinkelman.[3]

The criterion used for high school success was the Myers-Ruch High School Progress Test for English, social studies, mathematics, science, and total achievement ratings. The instrument used for evaluating certain personality characteristics was the Johnson Temperment Analysis. The data from this study were derived from thirty recently graduated high school students. The personality traits purportedly measured by this instrument are nine bi-polar traits: nervous-composed, depressive-gay hearted, active-quiet, cordial-cold, sympathetic-hard boiled, subjective-objective, aggressive-submissive, critical-appreciative, and self-master-impulsive.

The results of this study showed that three traits seemed to have the strongest relation to achievement, i.e. "objective", "composed", and "self-mastery". Three other traits, "appreciative", "submissive", and "active", also yielded statistically significant coefficients. Hinkelman concludes, "Recognition of the relatiun of personality factors to school achievement can make a vital contribution toward more accurate prediction of success."[4]

Other personality tests which have been used as predictors of success in high school are the Berneuter Personality Inventory and the Bell Adjustment Inventory. A study involving the Berneuter Personality

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[3] Emmet Arthur Hinkelman, "Relation of Certain Personality Variables to High School Achievement," School Review, 60:532-534, December, 1952.

[4] Ibid. p. 534.

Inventory as it relates to the prediction of academic success is reported by Nemzek.[5] With data on 92 and 99 sophomore boys and girls, Nemzek investigated the direct and differential predictive possibilities for the N, S, and D scores of the Bernreuter with honor point averages in several academic areas. The resulting direct and differential coefficients of correlation were so low as to be negligible. The results of this study confirmed the conclusion that Finch and Nemzek[6] came to with a similar study of the Bernreuter for the prediction of total scholastic achievement in high school. The authors concluded, "The data at hand furnished no evidence that the Bernreuter inventory is measuring any traits that contribute in any important degree to successful achievement in high school."[7]

Super[8] has summarized the research done on the Bernreuter and, in general, also found the trend for relationships between grades and Bernreuter scores to be negligible. Super[9] also reports that studies with the Bell Adjustment Inventory toward the prediction of grades

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[5]Claude L. Nemzek, "The Value of the Bernreuter Personality Inventory for Direct and Differential Prediction of Academic Success as Measured by Teachers' Marks," Journal of Applied Psychology, 22:576-586, December, 1938.

[6]F.H. Finch and Claude L. Nemzek, "The Relationship of the Bernreuter Personality Inventory to Scholastic Achievement and Intelligence," School and Society, 36:594-596, November, 1932.

[7]Ibid., p.596.

[8]Donald E. Super, "The Bernreuter Personality Inventory: A Review of Research," Psychological Bulletin, 39:94-125, March, 1942.

[9]Donald E. Super, Appraising Vocational Fitness (New York: Harper and Brothers, 1948), p.511.

have been negative.

Although it seems apparent that personality tests of various types do have some value in terms of their relationships with school success, the greatest weakness seems to be in the lack of sufficiently high reliability of the instruments themselves. Furthermore, most of the personality instruments on the market today have not been standardized with a view toward use in a typical educational setting. Many such inventories have been partially or wholly standardized and validated on special, atypical groups such as clinical cases.

There are many non-intellectual variables which could be related with achievement of academic success outside of those commonly measured by personality inventories. Three investigations of this type will now be reviewed.

The first is an investigation carried out by Curtis and Nemzek.[10] In this study, the authors investigated the relationships between certain unsettled home conditions and academic success. Six types of broken home conditions were studied; loss of father by death, loss of father by divorce or separation, unemployment of father, loss of mother by death, loss of mother by divorce or separation, and employment of mother outside the home. From the school records, fifty pupils were singled out for investigation in each of the six home conditions mentioned above. This group of 300 pupils was matched with 300 other pupils from normal homes on the basis of age, grade in school,

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[10]Erta Agnes Curtis and Claude L. Nemzek, "The Relation of Certain Unsettled Home Conditions to the Academic Success of High School Pupils," Journal of Social Psychology, 9:419-435, November, 1938.

sex and nationality. Honor point averages based on teachers' marks were used as the criterion of academic success. The data from this study showed that the achievement of pupils from broken homes was significantly inferior to that of pupils from normal homes. A further study of other factors such as amount of absence and tardiness, number of sisters and brothers, language spoken in the home, amount of outside employment, etc., failed to indicate any relation with the differential achievement observed.

A second study attempted to reveal the relationships between social-class and sex differences with high school achievement. Heimann and Schenk[11] selected a group of 114 sophomore students at random from the Wisconsin Counseling Study. This group was categorized into two social classes, Class III and Class IV, according to Hollingshead's classification (Class III being the higher social class). School achievement was indicated by the four year high school average for each student. Although students from four schools were involved, the authors used a normalizing and standardizing procedure on marks for each subject to account for school differences in marking. This is unique and an apparently sound approach to the problem. Through a study of the mean differences, it was found the average achievement of the higher social class was significantly greater than that of the lower social class. It was also found that girls (from both classes combined) achieved significantly higher than boys (from both classes combined).

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[11]Robert A. Heimann and Quentin F. Schenk, "Relations of Social Class and Sex Differences in High School Achievement," School Review, 62:213-221, April, 1954.

Among their conclusions the authors state, "Clinical evidences of differences in individual performance warn of the danger of over-generalizatinn of group data in relation to social class and sex differences in achievement."[12]

Studying boys and girls separately, Nemzek[13] attempted to determine the value of certain non-intellectual factors for the direct and differential prediction of academic success. He studied the predictive values of chronological age, the amount of education of the father and mother, and the occupational status of the father. The criteria uses for academic success were honor point averages in mathematics, English, languages, and art and vocational courses. Nemzek concluded that the aforementioned factors were of negligible value for purposes of prediction of academic success as measured by honor point average.

Among the numerous and varied factors that make for academic success, motivation is generally considered to be highly important. Since interest is a function of motivation, it is to be expected that the literature would contain many studies relating interest to achievement. One of the perturbing factors which influences the expected high degree of relationship between interests and achievement is that frequently students of high ability can achieve well in subjects even though they may lack intrinsic value in the subject. Such is particularly the case for college bound students who find it necessary to take certain subjects

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[12] Ibid., p. 220.

[13] Claude Nemzek, "Value of Certain Factors for Direct and Differential Prediction of Academic Success," Journal of Social Psychology, 12:21-30, August, 1940.

to qualify for college admission even though they lack interest in the subject. With this type of individual in the typical cross-sectional analysis, the correlations found between interest and achievement are naturally low. Such has been the case in most studies attempting to relate interest with achievement. One interesting approach to the solution of this difficulty was contrived by Thorndike.[14] Later this same approach was adapted for use by Frandsen and Sessions.[15] The approach simply eliminated the cross-sectional disturbances by finding the correlation between interest and achievement on an individual basis. Thus each subject ranks his interests in order and this is correlated with the ranked achievements in various subjects. Using this procedure, Frandsen and Sessions related the nine interest scales of the Kuder Preference Record to the achievement of 187 high school seniors in subjects which seemed to match the Kuder interest categories. They found a median intra-individual correlation of .27 between patterns of Kuder interests and achievement. The median correlations between self-rated interests and rank order of school achievement was found to be .51.

Townsend[16] studied the relationships between Strong's scales and scores on objective tests of school achievement made by 50 to 100

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[14]E.L. Thorndike, "Interests and Abilities," Journal of Applied Psychology, 28:43-52, April, 1944.

[15]Arden N. Frandsen and Alwyn D. Sessions, "Interest and School Achievement," Educational and Psychological Measurement, 13:94-101, Spring, 1953.

[16]A. Townsend, "Achievement and Interest Ratings for Independent School Boys," Educational Record Bulletin, 43:49-54, January, 1945.

students in private schools. The only significant relationships found were those between mathematics and science teacher-chemistry (r-.36), accountant-chemistry (r-.31), CPA-chemistry (r-.42), and mathematician-geometry (r-.31).

In reviewing the studies relating interests and achievement, one is impressed with the wide range of results and the apparent discrepancies reported even in similar subject-matter fields. This is, at least in part, due to the varying interest patterns of students from one school to another and/or the narrow range of interests exhibited by many high school students. Certainly the lack of reliable criteria is frequently the cause for low relationship. It is unfortunate that proportionately more time and concern is not spent in securing reliable and valid criteria.

Since the present study is concerned with the prediction of academic success through the use of tests measuring "intellectual" factors, our attention will now be turned to this topic.

Intellectual factors in the prediction of general academic success. Of the numerous studies carried out in the prediction of general academic success, the use of intelligence tests as predictors far surpasses the use of any other single predictor. Studies of this type, however, were much more frequent in latter decades than they are now.

The great bulk of prediction studies of general academic success

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[16] Ibid., p.49-54.

have been carried out on the college level. Those relating to prediction at the high school level are very frequently found as part of a study generally dealing with prediction in specific subject areas. The latter topic will be more fully explored in the following section.

To demonstrate the comparability of different mental tests to the problem of predicting academic success in high school, Jordan[17] applied four mental tests to the same group of children. He found the following correlations with average grades in all subjects:

Otis Intelligence	.450
Army Alpha	.476
Miller Mental Ability	.476
Terman Group	.492

Apparently the results derived from various mental tests do not differ significantly.

The lack of high correlation between the typical group test of intelligence and success in high school could be attributed to the relative lack of stability of these scores over those derived from individually administered intelligence tests. A comparison of the results of these two types of tests can be made in an investigation carried out by Proctor.[18] His results showed a correlation of .487 between the Stanford-Binet and average marks given over a two and one-half year period of time, and .586 with school marks averaged over a one year period. The respective correlations derived from the Army Alpha Group

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[17]A.M. Jordan, "Correlations of Four Intelligence Tests With Grades," Journal of Educational Psychology, 13:419-429, October, 1922.

[18]William Procter, "Psychological Tests as Means of Measuring the Probable Success of High School Pupils," Journal of Educational Research, 1:258-270, April, 1920.

Examination were .413 and .343. Apparently, the individually administered intelligence test proved to be a slightly better predictor of grades than did the group test.

Although the major purpose of the present study is to predict success in high school, the ultimate purpose is to be useful in helping students to choose appropriate high school majors. A study dealing with the selection of subject fields as they relate to intelligence was carried out by Powers.[19] In this study, Powers divided the students into quartiles on the basis of the Otis Intelligence Test. He found the highest quartile students tended to select, for the most part, advanced mathematics courses, and to follow consequtively the following subject fields in decreasing order: Latin, science, modern language, manual training and mechanical drawing, history, commercial subjects, and domestic art. The first quartile students tended to select those subject fields in an exact reverse frequency. The author concludes, "Students possessing superior intelligence are attracted to those subjects which make larger demands on intellectual capacity and lesser demands on manual dexterity."[20]

It would seem quite dangerous to generalize these results from school to school because of the varying values placed on different curricula. It is conceivable, for instance, for certain schools to attract the brighter youngsters in the manual arts if this type of skill

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[19]S.R. Powers, "Intelligence as a Factor in the Selection of High School Subjects," School Review, 30:455, June, 1922.

[20]Ibid.

is highly valued in the community.

Pintner[21] in summarizing the relationships between intelligence test scores and high school marks found that the coefficients ranged from .28 to .60 most of them being greater than .40.

In another summary by Ross and Hooks[22] the range of correlations, derived from a study of thirteen different mental tests by twelve different authors, was between .12 and .69 with a median of .48.

Other studies tend to confirm these general results. Nemzek[23] found, for example, correlations between intelligence tests and high school scholarship to range from .401 to .502 for boys and from .495 to .606 for girls.

Embree[24] undertook a study in an attempt to determine whether the predictive efficiency of certain measures differed with various levels of intelligence. His subjects were 271 high school graduates, each of whom had complete records from the eighth to twelfth grades. High school achievement was measured by the students' honor point ratio in the tenth, eleventh, and twelfth grades in senior high school. Three independent variables were used as predictors. These were ninth grade

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[21]Rudolf Pintner, Intelligence Testing Methods and Results (New York: Henry Holt and Company, 1931), p.555.

[22]C.C. Ross and W.T. Hooks, "How Shall We Predict High School Achievement," Journal of Educational Research, 22:184-195, October, 1930.

[23]Claude L. Nemzek, "The Value of Certain Factors for the Direct and Differential Prediction of Academic Success," Journal of Experimental Education, 7:199-202, March, 1939.

[24]Royal B. Embree, Jr., "Prediction of Senior High School Success at Various Levels of Intelligence," Journal of Educational Psychology, 28:81-91, February, 1937.

honor point ratios, a measure of intelligence, and age at entering the ninth grade. The subjects were divided into three I.Q. groupings; 90-109, 110-129, and 130 and above. Zero order correlations between each of the predictors and honor point ratios were computed for each of the three groups. It was found that no significant differences existed among the three groups in terms of their predictability with the independent variables used. By combining all three groups, the following relationships were uncovered. A correlation of .853 existed between ninth grade honor point ratio and the criterion. The I.Q. variable (based on the median of five standard intelligence tests) correlated to the extent of .596 with the criterion while age at entering high school correlated -.244 with the criterion. By combining the three independent variables, a multiple correlation of .893 was established with the criterion. The relationship between ninth grade honor point ratios and the average senior high school honor point ratio, partialing out the effects of I.Q., produced a correlation of .823, indicating the independence of this relationship with I.Q. The relative unimportance of the age factor is evidenced by the fact that the multiple correlation with the criterion using only the I.Q. and the ninth grade honor point ratio was .891.

The degree of relationship shown in this study is extremely high considering, especially, the fact that the subjects represent a rather restricted group even when the three I.Q. groupings were combined. The mean I.Q. of the total groups was 119.57 with a standard deviation of 12.38.

A notable aspect of this study is the fact that it represents

true prediction since the predictor measures were made before the criterion measures were secured. The extremely high correlation between ninth grade HPR and the average senior high school HPR is consistent with other findings which have shown that past achievement in school is one of the best predictors of future achievement.

Kelly,[25] for instance, correlated the marks given in grades four, five, six, and seven with marks given in the first year of high school. Beginning with the fourth grade and continuing through the seventh grade, he found the following correlations: .624, .531, .728, .719.

The eighth grade arithmetic average, eighth grade English average, ninth grade foreign language average and the I.Q. were used as predictors of the total high school average in a study by Dodes.[26] Two groups were studied; one group coming from a junior high school and one coming from an eight year elementary school. The correlation reported for the elementary group between the criterion and I.Q. was .45, while the English average correlated .18 and the arithmetic average .36. For the junior high school group, the correlations with the criterion were as follows; I.Q. .37, English average .50, arithmetic average .50, and language average .62. Using the best two predictors, I.Q. and language average, a multiple correlation of .77 was attained.

A correlation of .71 between average elementary school marks and

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[25]T.L. Kelly, Educational Guidance (New York Teachers' College Contributions to Education, No. 71, New York, 1914), p.116.

[26]I.A. Dodes, "Prediction of High School Success," High Points, 31:5-14, November, 1949.

and average high school marks was reported by Miles.[27] Another investigator, Ross,[28] reported a correlation of .60 between average elementary school marks and first year high school average. These investigations substantiate the high predictive power of past achievement to future achievement.

A study using a variety of predictors of high school academic success was carried out by Tozer.[29] In this study, Tozer studied 132 students in grades nine through twelve in an attempt to predict the average of all high school grades. The instruments used were 1) the Terman Group Test of Mental Ability, 2) the Cross English Test, 3) the Simms Score Card for Socio-economic Status, and 4) the New York Rating Scale for School Habits. Correlation coefficients relating each of these variables with grade point average were computed as well as the multiple regression equation. The correlations Tozer found with seventy-six sophomores and freshmen were: .75 with the Terman, .63 with the Cross English Test, .09 with Socio-economic Status, and .81 with ratings of school habits.

With fifty-six senior and junior students in the same high

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[27] W.R. Miles, A Comparison of Elementary and High School Grades (University of Iowa, Studies in Education, Vol. 1, No. 1, Iowa City, Iowa, 1911), p.22.

[28] C.C. Ross, The Relation Between Grade School Record and High School Achievement (New Teachers' College, Contributions to Education, No. 166, New York, 1925), p.70.

[29] G.E. Tozer, "A Statistical Prediction of High School Success for Purposes of Educational Guidance," Journal of Educational Research, 22:399-402, November, 1930.

school, the correlations with the variables in the same order were .65, .70, .22, and .88 respectively. These results tend to indicate the value of intelligence and the importance of good school habits to school success. For the group of ninth and tenth graders, the multiple correlation using a combination of all the variables was .881, while the multiple correlation for the eleventh and twelfth graders was found to be .91. Tozer concluded that the results of the study tended to show that if a counselor had an accurate rating for school habits as well as the rating of the intelligence level of a student, the counselor would be materially aided in his guidance insofar as advising the individual to take certain work in the regular academic curriculum.

The high correlation derived from the rating of school habits is less impressive when one realizes the ratings were made by the very teachers who were the source of the criterion measures (grades). It would have been preferable to obtain an outside measure of this variable. Furthermore, this study cannot be considered as predictive in nature since the variables were obtained at the same time as the criterion measure. Thus, validity is of the concurrent type rather than the predictive type.

II. STUDIES RELATING TO PREDICTION IN SUBJECT AREAS

In recent years, the instruments given the most attention in the prediction studies of high school success are the multiple aptitude batteries. Several of these studies will be reviewed now in an attempt to cover some of the better known batteries as they relate to academic success in subject areas.

One battery of aptitude tests which has received much attention in the field of education is the Primary Mental Abilities (PMA) battery. One of the basic differences between this battery and the Differential Aptitude Battery (four subtests of which are used in this study) is that, although the two are based on factor analytic procedures, the DAT was constructed with a view toward educational use (thus the Spelling and Sentences subtests) while the Primary Mental Abilities Tests are oriented more toward factorial purity.

For purposes of studying the relationships between the Primary Mental Abilities Tests and achievement in various fields, Shaw[30] administered the PMA to a group of 591 ninth grade students in two schools in Iowa. The PMA Tests, consisting of the following subtests: Verbal-Meaning, Word-Fluency, Reasoning, Memory, Number, and Space, were correlated with the following measures of achievement; the Iowa Tests of Educational Development, the Cooperative Reading Test, Reading Comprehension and an experimental reading test. Thirteen measures of achievement were thus derived. The ranges of zero order coefficients obtained for each subtest of the PMA are as follows: Verbal-Meaning, .404 to .793; Word-Fluency, .161 to .419; Reasoning, .197 to .562; Memory, .116 to .287; Number, .090 to .434; and Space, .061 to .389.

Using the composite score of the Iowa Tests as a measure of general academic success, the Verbal-Meaning Test correlated .793,

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[30]Duane C. Shay, "A Study of the Relationships Between the Thurstone Primary Mental Abilities and High School Achievement," Journal of Educational Psychology, 40:239-249, April, 1949.

while the Reasoning Test correlated .501; Number, .359; Word-Fluency, .355; Space, .350; and Memory, .238.

The highest relationship is seen to exist between the Verbal-Meaning Test and the criterion. The multiple correlation of the PMA to the Iowa composite score criterion was .824. The difference between this correlation and the Verbal-Meaning Test alone (.794) is not appreciable.

To say that the PMA Tests are factorially pure is obviously a matter of degree. Although the inter-correlations of the subtests were not presented in the aforementioned study, it is clear they must be high because of the small increase in multiple correlation over the correlation derived from the best single test and the criterion. It will be noted that in no instance was the term "prediction" used either in the study itself, or the writer's reporting of this article. The PMA and the achievement measures were given concurrently; thus no true prediction was made. Rather, the relationships reported simply reflect the degree to which the PMA could be used as substitutes for the achievement measures. It is unfortunate that the PMA Tests have not been as well validated as some of the other batteries of aptitude tests.

One battery of uni-factor tests which was intensively investigated in a study by Mitchell[31] is the Holzinger-Crowder Uni-Factor Tests. The problem of the study was to determine the extent to which

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[31]Blythe C. Mitchell, "The Relation of High School Achievement to the Abilities Measured by the Holzinger-Crowder Uni-Factor Tests," Educational and Psychological Measurement, 15:487-90, Fall, 1955.

this battery would serve as predictors of high school achievement. The battery furnishes separate measures of Verbal, Spatial, Numerical and Reasoning ability.

The criterion measures were both achievement test results and teachers' marks. The groups studied represented students from fourteen different communities, although each set of validity coefficients was based upon the results for a single grade in one community. On the whole, the correlations reported in Mitchell's study represent concurrent validities, since in most cases both predictor and criterion measures were secured within several weeks of one another.

Eight achievement tests were used as criteria for the prediction of grades in mathematics. The range of correlations established for the Verbal Test in predicting mathematics achievement was between .44 and .64; the Spatial Test correlations ranged from .28 to .48; the Numerical Test from .34 to .76 and the Reasoning Test between .44 and .67.

In the area of science, five standardized tests were used as criteria. The range of correlations for each of the predictors is as follows; Verbal, .60 to .75; Spatial, .17 to .39; Numerical, .30 to .47; and Reasoning, .46 to .61.

In social studies, four achievement tests were used as criteria. The range of correlations for the Verbal Test was .58 to .65; Spatial, .18 to .37; Numerical, .26 to .39; and Reasoning, .41 to .46.

Language arts was measured through the use of six different achievement tests. The range of correlations for the Verbal Test was .51 to .80; Spatial, .16 to .39; Numerical, .21 to .58; and Reasoning, .43 to .72.

Using the median score of the Essential High School Content Battery as a measure of the total achievement, the Verbal Test correlated .77; Spatial, .31; Numerical, .50; and Reasoning, .58.

Using the teachers' marks as the criterion of school achievement, the correlations between the predictor tests and twenty-seven subjects were computed. For purposes of summarization, the subjects that were clearly defined in a subject area were combined. The ranges of correlations together with the respective medians are presented in Table 1.

An inspection of Table 1 shows that on the whole, the prediction of achievement in the tool subject areas is higher than in other areas. It will be noted also that on the whole, prediction of achievement test results is considerably higher than the prediction of teachers' grades. The Verbal Test seems to be one of the best all around predictors of school achievement, and probably represents a substantial portion of what is commonly called general intelligence.

In addition to the zero order correlations, Mitchell also reported multiple correlations using the combined four predictor tests in predicting scores on various standardized tests. Since the Essential High School Content Battery is used in the present study, the multiple correlations he reports with each of its subtests are of interest. They are as follows:

EHSCB	Multiple R
Mathematics	.723
English	.780
Science	.771
Social Studies	.620

TABLE 1

SUMMARY OF THE CORRELATIONS BETWEEN THE HOLZINGER-CROWDER UNI-FACTOR TESTS AND TEACHERS' MARKS IN CERTAIN HIGH SCHOOL SUBJECT AREAS[32]

Subject Area	Median N	Range of r's	Median r	Best Predictor
English	361	.16 to .58	.46	Verbal
History	353	.33 to .60	.46	Verbal
Mathematics	96	.15 to .55	.42	Reas. and Verb.
Science	184	.34 to .57	.49	Verbal
Home Economics	38	.10 to .56	.36	Reasoning
Business Education	78	-.01 to .61	.33	Numerical
Industrial Arts	48	-.06 to .45	.13	Spatial

[32] Ibid., p. 89.

It will be noted the highest prediction is English, followed by science, mathematics and social studies. It will be of interest to compare these results with those obtained in the present study.

Segel[33] attempted to determine the validity of an aptitude battery by administering the Multiple Aptitude Test to a representative school population for purposes of secondary school guidance work. This battery included measures of Word Fluency, Language Fluency, Mathematical Reasoning, Spatial Relationships and Mechanical Reasoning. The battery was adapted from aptitude tests in the War Department.

One of the methods used for investigating the validity of this battery was an approach similar to the one used in this study, i.e. to determine its power to predict success in high school subject areas. Although the tests comprising the battery do not exactly coincide with the ones used in this study, there is enough similarity for comparative purposes. Four tests were thus singled out for comparative purposes.A partial reproduction of the table Segel reported, showing the correlation of the four tests with grades in five subject areas, is shown in Table 2.

It is clear through an inspection of Table 2 that most of the correlations probably do not represent relationships greater than chance expectation.

In the subject areas in which the respective tests seem to have

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[33]David Segel, "The Validity of a Multiple Aptitude Test at the Secondary Level," Educational and Psychological Measurement, 7:695-705, Spring, 1947.

TABLE 2

CORRELATIONS OF FOUR MULTIPLE APTITUDE TESTS WITH TEACHERS' MARKS IN FIVE SUBJECT AREAS[34]

Subject Area	N	Mechanical Aptitude	Word Fluency	Language Usage	Mathematical Reasoning
Industrial Arts	87	.48	.09	.12	.26
Foreign Language	78	-.04	.20	.54	.32
Social Studies	112	.25	.30	.10	.23
English	120	.02	.49	.32	.11
Mathematics	104	.20	.19	.30	.62

[34] Ibid., p. 703.

the greatest face validity, however, predictions are fairly high. Industrial arts correlated .48 with the Mechanical Aptitude Test; foreign language correlated .54 with the Language Usage Test; English correlated .49 with the Word Fluency Test; and mathematics correlated .62 with the Mathematics Reasoning Test.

In his conclusion, Segel stated that this study supports the hypothesis that a multiple aptitude test of this type is of value for differential diagnosis and prognostic work.

Wolking[35] used the Primary Mental Abilities and the Differential Aptitude Tests in predicting success in high school subject areas. For comparative purposes, he selected three tests from each battery which measured similar abilities, i.e. the verbal, number, and spatial tests. Computing separate correlations for 139 girls and 128 boys between the three tests and teachers' grades, the following general results were obtained.

1. For both boys and girls, the DAT number test correlated highest with grades in English (.55 and .58 for boys and girls, respectively), and grades in science (.69 for both boys and girls). Mathematics grades were best predicted by the DAT verbal test for boys (.66) and the DAT number test for girls (.67). Marks in home economics and industrial arts showed no significant relationship to any of the tests.

2. The reported correlations were generally higher for girls than they were for boys; however, regardless of sex, all the tests proved to

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[35] William D. Wolking, "Predicting Academic Achievement with the Differential Aptitude and the Primary Mental Abilities Tests," Journal of Applied Psychology, 39:115-118, April, 1955.

be most valid for predicting grades in science.

3. The number test of the DAT was the best over-all predictor of academic success; its correlations with all subject areas except home economic and industrial arts being .55 or higher.

4. The DAT verbal test proved to be the second best over-all predictor of academic success, while the PMA verbal test was the third best over-all predictor of success.

5. For the most part, the Differential Aptitude tests proved to be superior to the Primary Mental Abilities tests in terms of their relationship with marks in the various subject areas.

6. The study indicates some potential for the predictinn of academic success in general, but throws some doubt on the immediate usefulness of the various subtests as differential predictors of success in various subject areas.

There probably has been no other test or battery of tests for which more validation data has been supplied than the Differential Aptitude tests. Thousands of correlation coefficients have been reported indicating the relation of these tests to school marks, achievement tests, and other criteria of success. Fortunately, the authors of this battery have summarized the results of numerous studies in their manual by providing median correlations for boys and girls in most of the subject areas. In subject areas in which median correlations were not reported, they were computed by the writer. The DAT subtest, providing the highest median correlation with each of the subject areas of interest in this study, is shown in Table 3 for boys and girls separately.

Table 3 reveals a number of interesting facts. Except in the

TABLE 3

DAT SUBTESTS PROVIDING THE HIGHEST MEDIAN CORRELATION WITH EACH OF THE EIGHT HIGH SCHOOL SUBJECT AREAS FOR BOYS AND GIRLS[35]

Subject Area	Sex	Best Predictor Test	Median r
English	Boys	Sentences	.50
	Girls	Sentences	.53
Social Studies	Boys	Verbal Reasoning	.48
	Girls	Verbal Reasoning	.52
Science	Boys	Verbal Reasoning	.54
	Girls	Verbal Reasoning	.55
Mathematics	Boys	Numerical Ability	.47
	Girls	Numerical Ability	.52
Foreign Language	Boys	Sentences	.51
	Girls	Numerical Ability	.42
Industrial Arts*	Boys	Numerical Ability	.28
Home Economics	Girls	Numerical Ability	.32
Business Education	Girls	Sentences	.39

*Includes the DAT manual areas of industrial arts, mechanical drawing, shop, and woodworking.

[35]Bennett, Seashore and Wesman, op.cit., p.40-51.

area of foreign language, higher relationships between the tests and marks are seen to exist for girls than for boys. Secondly, the tool subject areas (and foreign language) are seen to relate higher to the predictors than do the remaining three subject areas, i.e. industrial arts, home economics and business education. The Sentences, Verbal Reasoning, and Numerical Ability Tests are seen to be among the best three predictors of school marks.

The Differential Aptitude Tests have also been studied in terms of their relation to achievement test scores as criteria of success in subject areas. Although the DAT manual reports the results of numerous correlational studies with various standardized tests, the results of studies using the Essential High School Content Battery (EHSCB) as criteria are of particular interest, since this instrument is used as an alternate criterion in the present study.

The Numerical Test of the DAT proved to show the highest relationship to the Mathematics Test of the EHSCB for both boys and girls, the correlations being .66 and .56 respectively. The Science Test was best predicted by the DAT Verbal Reasoning Test with correlations of .65 for boys and .62 for girls. The Verbal Reasoning Test also correlated highest with the Social Studies Test to the extent of .57 for boys and .58 for girls. The highest correlation in predicting the English scores of girls was shown by the Sentences Test (.66), while for boys, the Verbal Reasoning Test proved to be the best predictor (.65). The composite score of the EHSCB was predicted highest by the Verbal Reasoning Test for boys (.75) and by the Sentences Test for girls(.67).

It is seen that the three DAT Tests showing the highest median

correlations with school marks; the Verbal Reasoning, Numerical Ability, and Sentences Tests also are the same three subtests which correlate highest with the EHSCB. From this, one might speculate that few courses or subject areas require special abilities, as such, but rather require various degrees of a generalized factor.

In investigating a problem of transfer of training, Wesman[36] administered tests measuring achievement and intelligence. The intelligence test measured verbal, numerical, and spatial abilities and the achievement test covered social studies, natural science, mathematics, literature, reading comprehension, contemporary affairs, and a foreign language. He obtained an average correlation of .485 between verbal ability test and the various measures of scholastic achievement. The average coefficient between number ability and the same measures was .35 while the average correlation derived from the spatial test was .285.

Holzinger and Swineford[37] investigated the relation of two bi-factors to achievement in several subjects. They reported a multiple correlation of .768 between a general mental factor on the one hand and the American Council Cooperative Plane Geometry Test scores on the other. Zero order coefficients, reported in such subjects as English, biology, foreign language, chemistry, history, shop and crafts, and

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[36]Alexander G. Wesman, A Study of Transfer of Training (New York Teachers' College, Contributions to Education, No. 909, New York, 1945), p.25.

[37]Francis Swineford and Karl J. Holzinger, A Study in Factor Analysis: The Reliability of Bi-Factors and Their Relation to Other Measures (University of Chicago, Supplementary Educational Monographs, No. 53).

drawing ranged from .219 to .586 for the "general mental factor" and from -.003 to .682 for the spatial factor.

General intelligence tests also have been used by various investigators for prediction of success in subject areas. One such study was conducted by Ohlson.[38] In this study, Ohlson investigated the Terman Group Test scores of 200 boys and 306 girls to ascertain what correlation, if any, existed between the mental ability of the students and the marks they received in high school. The Terman Test was given during the students' last year of high school. The correlation between the Terman Group scores and the average marks received by the total group of 506 pupils was .38. The highest correlation was seen to exist with marks in English; the correlation being .45. The mathematics and science departments, with about the same number of students, showed lower correlations, which was also true of the foreign language department; being .33, .31, and .24 respectively. In the vocational department, commercial, home economics and art, and manual arts, the correlation between the Terman Test and school marks was very slight, being .18, .12, .15 respectively. Marks in history correlated to the extent of .37 with the Terman Test.

Ross and Hooks[39] summarized a group of correlations relating intelligence tests and achievement in high school subjects, such as English, Latin, and mathematics. The coefficients they reported ranged

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[38]David Ohlson, "School Marks and Intelligence," Educational Administration and Supervision, 13:90-102, February, 1927.

[39]C.C. Ross and W.T. Hooks, "How Shall We Predict High School Achievement?" Journal of Educational Research, 22:184-95, March, 1930.

from .18 to .72 with a median of .39.

Eurich and Cain[40] in summarizing the results of correlational studies between intelligence and high school achievement as reflected in grades, calculated the median correlations of more than 300 coefficients reported in various studies. In the area of science, the median correlation was found to be .44; in mathematics .37; in foreign language .33; and in history and English, .45. The median correlations reported between intelligence tests and achievement test results were: .45 in science .41 in mathematics; .46 in foreign language; and .27 in history and English. The authors state, "Although the coefficients occassionally fell in the lower .70's, the summary indicates clearly that intelligence tests cannot be depended upon with any high degree of accuracy for predicting achievement in specific subjects."[41]

Aaron[42] also has summarized a number of investigations attempting prediction of high school achievement. Although the correlations reported relate to subjects rather than subject areas, the results are worth reporting. Her summary includes the median correlations established for intelligence tests in predicting success (as indicated by teachers' marks) in high school algebra, plane geometry, Spanish, biology, physics, and chemistry. These correlations were found to be

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[40]Alvin C. Eurich, and Leo F. Cain, "Prognosis in Secondary Schools," Encyclopedia of Educational Research, 1941 Edition,pp. 844-859, 1941.

[41]Ibid., p.846.

[42]Sadie Aaron, "The Predictive Value of Cumulative Test Results," (Doctor's Thesis, Stanford University, California, 1946), p.227.

.48 for algebra, .44 for geometry, .35 for Spanish, .51 for biology, .53 for physics, and .29 for chemistry.

Many studies have also been conducted in which the prediction was focused on one subject area only. Several of these studies will now be reviewed with an emphasis on those subject areas in which comprehensive reviews have not been made.

Prescott[43] reported a study in which he attempted to determine the effectiveness of the Turse Clerical Aptitudes Test in predicting success in commercial subjects. Since this subject area includes subjects in business education, an area considered in the present study, the results will be of interest.

The Turse Clerical Aptitudes Test includes separate measures of Verbal Skills, Number Skills, Learning Ability, Clerical Speed, Clerical Accuracy, and General Clerical Aptitude. The criterion measures included teachers' marks and achievement tests. The subjects were students entered in the commercial curricula at two large high schools.

Correlations between the Verbal Skills, Number Skills, Clerical Speed, and General Clerical Aptitude and various achievement tests ranged from .32 to .68 with a median of .58, while the range of correlations reported with teachers' marks for the same four predictors was .36 to .70 with a median of .51.

An investigation was undertaken by Limp[44] to select a battery of

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[43]George A. Prescott, "Prediction of Achievement in Commercial Subjects," Educational and Psychological Measurement, 15:491-492, Winter, 1955.

[44]C.E. Limp, "A Work in Commercial Prognosis," Journal of Educational Research, 16:46-56, June, 1927.

tests which would predict the ability of high school students to succeed in typewriting and stenography. Forty tests were administered including intelligence, will-temperament, motor, and secretarial skills tests as well as tests of attention, perception, speed and coordination of reaction, and ability to follow directions. The subjects of this study were 118 beginning students in typewriting and shorthand. The criterion of success in typewriting and shorthand was a combination of weekly speed tests, average rankings by teachers, and a semester grade. The highest correlation between the predicted scores and the criterion scores was .61 for shorthand and .62 for typewriting. His findings showed that secretarial aptitude can be predicted to a fairly high degree.

Whiteley[45] also undertook a study to determine the ability of certain standardized tests to predict secretarial success. The subjects were 108 students in the Packard School of New York City. Two criteria of success were used; the completion of the course in shorthand, and the time taken to finish the course. Students were advanced as readily as they progressed. The tests administered were the Army Group Examination (Alpha), the Hoke Prognostic Test of Stenographic Ability, the Woodworth-House Mental Hygiene Inventory, and the Sim's Socio-Economic Rating Scale.

The significant findings of Whiteley's study were: 1) There was a definite negative relation between the time it took to finish the

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[45]Sarah S. Whiteley, "Predicting Stenographic Success Through Prognostic Tests," The Balance Sheet, 18:242-44, March, 1932.

course and the scores obtained on the Army Alpha; 2) the Sims Rating Scale failed to descriminate between students who finished the course and those dropping out; 4) the Hoke prognostic Test of Stenographic Ability proved to be the best single predictor of success in this course as measured by the completion of the course and the time taken to finish the course. The Hoke Test did not, however, differentiate between graduates and drop-outs.

In the subject area of mathematics, Lee and Hughes[46] studied 329 students taking algebra and geometry. Teachers' marks and achievement tests were used as criteria of success. The predictors used in their investigation included the Lee Test of Algebraic Ability (and Geometry Aptitude), the Hughes Trait Rating Scale, the Kuhlman-Anderson and Terman Group intelligence tests, and teachers' ratings of mathematical ability made two weeks after the students had entered the courses.

The aptitude tests gave the best single prediction with achievement test scores in algebra (.62) and geometry (.63), followed by the Kuhlman-Anderson Test which predicted algebra and geometry achievement to the extent of .56 and .54,respectively. The best predictors of teachers' marks proved to be their own ratings at the beginning of the courses. The correlations were .59 and .42 for algebra and geometry, respectively. Trait ratings were found to be much more important in predicting marks than they were in predicting achievement test results.

On the whole, the order of merit for predicting achievement in

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[46] J. Murray Lee and W. Hardin Hughes, "Predicting Success in Algebra and Geometry," School Review, 42:188-96, March, 1934.

mathematics seems to be: 1) good prognostic tests, 2) mathematics marks for the previous year, 3) intelligence quotient, 4) mental age, 5) achievement tests in arithemetic and algebra, and 6) average marks in previous years.[47]

Many studies have been conducted for purposes of predicting success in foreign language. Seagoe,[48] for example, studied 120 students in the seventh grade in an attempt to predict their achievement in foreign language over a three year period. The predictor tests used included the Terman Group Test, Kuhlman-Anderson Test, Otis Intermediate Test, the New Stanford Achievement Test, the Luria-Orleans Modern Language Prognosis, the Stenquist Mechanical Aptitude Test and the Orleans Algebra Prognosis Tests. The mathematics tests were included to determine the comparative relationship to, or independence of, the foreign language prediction. Certain sections of the Stanford Achievement Test and the Mechanical Aptitude Tests were included to explore the relation of foreign language achievement to such theoretically unrelated factors as scientific and practical ability.

The median correlations with course records were as follows: language prognosis .73; algebra, .46; reading achievement, .49; intelligence tests, .53; arithmetic achievement, .50; physiology achievement, .40; and Stenquist Mechanical, -.11. Reading achievement seemed to be less valid than either the general intelligence or language prognosis

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[47]H.R. Douglass, "Special Methods on High School Level: Mathematics," Review of Educational Research, 2:7-20, 81-82, February, 1932.

[48]M.V. Seagoe, "Prediction of Achievement in Foreign Language," Journal of Applied Psychology, 22:632-640, December, 1938.

tests.

Most of the studies of prediction of foreign language achievement have been summarized by Kaulfers.[49] Some of the median correlations he reports with various measures are .600 with prognosis tests, .49 with achievement in algebra, .46 with achievement in English, .385 with achievement in reading, .356 with intelligence tests, .164 with achievement in arithmeitc, and -.24 with chronological age. The great range of correlations reported, varying from low negative to nearly perfect positive correlation for a single characteristic, is noteworthy.

III. SUMMARY

It is apparent that in the vast majority of studies reported in the literature, correlational techniques are the most common methods of showing the relationships between various predictors and criteria of achievement. For the most part, the correlations range from .40 to .60 with a few reaching the .70's. The prediction of general academic success seems to show correlations of about the same magnitude as those shown in predicting success in subject areas and specific subjects. Although the correlations are sufficiently high to make them useful in studying groups, they are not sufficiently high to warrant their use on individuals in a counseling situation - at least when considered alone. Individual predictions of success in high school, based on tests or other measures, can be considered only a small segment of the total picture that is needed in aiding students to make wise selections of

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[49] Walter Vincent Kaulfers, "Present Status of Prognosis in Foreign Language," School Review, 39:585-596, June, 1931.

subject areas at the high school level.

As is the case in most studies of prediction, there are two fundamental considerations. They are the reliability and validity of the criterion, and the reliability and validity of the predictive measure. For the most part, the reliability of tests, as predictors is sufficiently high to warrant their use. The reliability of school marks, however, has been shown repeatedly to be low. The validity of marks also may be seriously questioned as indicators of success in school.

The use of achievement tests as criteria of success may have their advantages as more reliable measures, but their validity in specific situations is difficult to ascertain. Certainly the successful outcomes of courses of instruction cannot be measured totally by paper and pencil tests. The more intangible outcomes, however, may be and usually are, reflected in teachers' marks. It is seen, therefore, that both types of criteria of school success have their assets and limitations.

The prediction of academic success of girls is generally of a higher magnitude than that of boys, although the magnitudes of correlations reported in subject areas are too wide in range to make it possible to rank subject areas in order of their predictability. On the whole, however, the typical tool subject areas, i.e. English, mathematics, science and social studies, seem to be susceptible to higher prediction than the vocational subject areas such as industrial arts, home economics and business education.

The use of personality tests as predictors of academic success have shown widely diversified results. Such is the case with other

non-intellectual variables. On the whole, however, the results of predicting success with non-intellectual variables has shown lower measures of relationship when compared to the results derived from the use of intellectual measures. The multiple prediction of success in school, using a combination of intellectual and non-intellectual variables as predictors, has proven to be a fruitful approach because of their relatively low inter-correlations.

The next chapter describes the criteria and sources of data which were used in the evaluation of the seven tests used in this study as predictors of high school achievement.

CHAPTER III

THE CRITERIA AND SOURCES OF DATA

I. THE CRITERIA

Prediction in specific subjects versus prediction of subject-matter areas. Since standardized tests began to be used, hundreds of studies have been made in an attempt to predict academic success at all educational levels including, of course, the high school level. Most of these studies deal with the prediction of success in certain specific subjects such as biology, algebra, Spanish, etc. The assumption is made that there may be differential prediction among specific subjects. This assumption finds some support in the fact that students often do not achieve the same degree of success in one subject as they do in another. These differentials are the result of many factors such as interest, aptitude, past success in the subject area, and teacher differences. The results of such studies, however, are too often of limited guidance value. The typical eighth grader is not as much interested in his success in a particular subject as he is in his possible success in various areas of academic study. For example, the more fundamental decision will be based on whether one should major in science rather than whether one should pursue chemistry, physics, etc.

This approach makes more sense from at least two points of view. First, in most high schools, a certain number of high school majors (similar to those defined in this study) must be selected as part of the graduation requirements. From this viewpoint, the junior high school

student entering high school must make decisions in terms of the selection of subject areas to constitute his majors.

Secondly, it is common knowledge that one of the most important factors in the academic success of a student is the complexity of attitudes, interests and motivations which make up his "pre-perspective" of the subject matter. On this basis, it is maintained that a student's perspective is more oriented toward a subject field or area rather than toward specific subjects, primarily because he has some notion through past experience as to the nature of most subject areas. For example, the typical junior high school student has some idea concerning the nature of science, mathematics, social studies, and industrial arts because in many cases he has had some contact with these areas in past curricula. Within the area of science, however, he may have no notion as to what biology is.

Thus, one of the basic assumptions to the approach of this study is that students tend to select specific subjects within the areas in which they feel they have a desirable perspective. It follows, therefore, that in using this holistic approach, prediction of academic success in subject areas will prove more useful.

Two criteria serve as a basis for this study - grade point averages and scores on the Essential High School Content Battery. The former serve as the major criterion since the major purpose of this study is to predict the high school grades in subject matter areas. The latter criterion is more supplementary and is used for comparative purposes and as a check on the validity of grades. It should be noted, however, that although prediction is to be attempted in eight high school subject

matter areas, i.e. business education, English, foreign language, home economics, industrial arts, mathematics, science, and social studies, the EHSCB serves as a check on only four of the areas (English, mathematics, social studies, and science). In addition, the total score on the EHSCB will serve as a supplementary criterion for the total grade point average, which is the criterion for general academic success.

Much has been written concerning the use of the grade point average as a criterion for success in course work. Many weaknesses are evident in this criterion. Among these weaknesses are those with reference to the un-reliability of grades; teacher, school and system wide differences in grading practices; and the lack of ability to measure accurately varying objectives, content, and educational outcomes. It is argued, then, that success in education cannot be reflected in a school grade. To some extent, the presence of these limitations cannot be denied; however, when all is said and done, it still remains a fact that students, parents, teachers, administrators and business and industry rely to a considerable extent upon school grades as a reflection of a student's academic success. No other defense for the use of this criterion will be made. It seems obvious that the important fact to be remembered is that the criteria for success <u>are</u> grades and to accept the results in light of this fact, with due cognizance of their limitations.

<u>The courses constituting a subject-matter area</u>. Before the procedure for determining grade point averages can be described, it is necessary to define first the courses making up a subject-matter area. For this purpose, the <u>Program of Studies</u> of the Cincinnati Public

Schools was used. In this Program of Studies, ten subject-matter areas are delineated, two of which (Music and Art) are not included in this study because of the small numbers of students selecting these areas for high school majors.

Since a major is defined as any combination of three or more units in a subject-matter area, it is obvious that a major may be many different combinations of courses within an area. Since the approach of this study is to determine whether "holistic" prediction can be made, it is not necessary to know what exact combination of courses is involved. To indicate the courses most commonly used as majors in each subject-matter area, and the courses which constitute each of the eight subject areas, the following table is presented.

TABLE 4

SUBJECT MATTER AREAS DEFINED BY THEIR CONSTITUENT COURSES

Subject Area	Constituent Courses**
Business Education	Typewriting I*, II* World Geography Business Arithmetic Consumer Education Shorthand I* Bookkeeping I,II Salesmanship and Advertising Secretarial Practice with Shorthand II* Office Practice*
Foreign Language	French I*, II*, III, IV German I*, II*, III, IV Spanish I*, II*, III, IV Latin I*, II*, III, IV

TABLE 4 (continued)

English (English I, II, III required of all students)	English I*, II*, III*, IV Dramatics Public Speaking Journalism Advanced Speech Debating
Home Economics	Home Economics I*, II*, III* Consumer Education
Industrial Arts (majors about equally distributed among all courses)	Electricity I, II Metalwork I, II Woodwork I, II Mechanical Drawing I, II, III, IV Graphic Arts I, II
Mathematics (one unit of Mathematics required of all students)	General Mathematics Plane Geometry* Business Arithmetic Algebra* Consumer Mathematics Mathematics III* (primarily Advanced Algebra) Mathematics IV* (primarily Solid Geometry and Trig.)
Science (one unit required of all students)	General Science Biology* Botany Zoology Chemistry* Physics* Physiology*
Social Studies (two units required of all students)	World History* World Geography American History* Economics and Sociology (each met one semester) American Problems*

*Indicates those courses most commonly chosen to constitute majors.

**Each course here presented carries one high school unit of credit and meets five periods per week for the full year of school.

Method of determining grade point averages. All course grades were converted to the typical four-point scale, ranging from 0.0 to 4.0, or from the lowest "F" to the highest "A", respectively. The final course grades from two of the six schools originally studied, recorded grades in this manner so that no conversion was necessary. In three of the remaining high schools, grades were recorded on a thirty-two point scale, this score representing the sum of semester grades. The conversion to a four-point scale simply involved dividing the score by eight. The remaining schools recorded grades as A, B, C, D, F. This system was converted by ascribing 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.

After the scores in all six schools were converted to the common four-point scale, grade point averages in majors were calculated by dividing the sum of all courses taken in a subject area (the minimum, of course, being three) by the number of courses taken. In the great majority of cases, this average was based on the grades in three courses. Some averages were based on grades in four courses, and very rarely did five courses comprise a major.

The total grade point average, which is used as the criterion for general academic success, was derived by computing the average grades in all one unit courses whether the course was a part of a major or not. This average did not include such courses as Physical Education or Health since these courses carry only one-half unit of credit. In general, the total grade point average was based on between fifteen and eighteen course grades.

The comparability of criteria between schools. As stated previously, the original subjects of this study came from all six comprehensive high schools of the Cincinnati Public Schools. Since there is a significant variability in the nature of the student population attending these schools, a serious question arises. Do grade point averages reflect a similar standard from school to school? In other word, does an "A" given in School "X" carry the same significance as an "A" given in Schoot "Y"? Obviously, before the subjects in each school could be pooled and treated as a single population, it would be necessary to answer this question.

The reasoning used in determining the answer to this question was as follows: if a direct analysis of the significance of difference between grade point average means in the criteria among schools were used, the fact would be overlooked that there are individual differences in the capability of youngsters comprising a school. In other words, by using an analysis of variance, for example, suppose it was found that significant differences existed in the criteria between the schools. Suppose, however, that although School "X" did have a significantly higher grade point average than school "Y", it also had a higher level of scholastic ability. Then, one would expect a difference in the criterion scores merely on the basis of differences in initial levels of ability. In such a case, if no differences were found in criterion scores, then one could conclude that there probably are differences in grading practices between the schools.

To approach the problem in this light, the method of analysis of covariance was used. Using this method, the criterion means were

adjusted statistically, relative to the levels of ability of the groups involved. The instrument used to estimate the ability levels of the schools was the American Council on Education Psychological Examination (1948 high school edition). This instrument was administered in February, 1956 when the subjects were high school juniors.

Before proceeding with this analysis, however, there was reason to believe that one of the high schools would not conform to the grading practices in the other schools. This school is a college preparatory school, admitting only students with an I.Q. of 110 or above, with high past achievement records, and with the recommendation of the principal of the school previously attended. This fact is shown in the following table where a comparison with other schools can be made.

The college preparatory school just mentioned is seen as School 6 in Table 5. It will be noticed that with the mean ACE score of 114, it

TABLE 5

TOTAL GRADE POINT AVERAGE AND ACE MEANS FOR THE SIX CINCINNATI PUBLIC HIGH SCHOOLS

School	N		Total Grade Point Average Means	ACE Means
1	168		2.22	77.5
2	117		2.16	45.9
3	221		2.66	91.6
4	206		2.32	83.1
5	182		2.36	89.3
6	163		2.40	114.0
Totals	1057	Total mean	2.33	83.56

would be necessary for this school to give an average grade point average of well over 3.5 to be consistent with the grading practices in the other schools relative to the ability levels of the student body. In

addition, this school does not offer "non-academic" courses such as Industrial Arts, Home Economics, and Business Education from which a student can select a major. For these reasons, School 6 was immediately excluded from further analysis.

A subsequent analysis of the total grade point averages in the remaining five schools gave the results shown in Table 5. Random samples of fifty students from each school were used in this analysis. Samples were drawn by use of a table of random numbers. The level of significance arbitrarily selected was at the five per cent level of confidence.

The F ratio in the above analysis indicates significant differences in the criterion means even when adjustments are made for levels of ability as measured by the ACE. By using a series of designs such as the one above for not only total grade point average but also for grade point averages in the subject areas, and by withdrawing those

TABLE 6

RESULTS FROM AN ANALYSIS OF COVARIANCE OF TOTAL GRADE POINT AVERAGES ADJUSTING THESE MEANS FOR LEVELS OF SCHOLASTIC ABILITY IN FIVE CINCINNATI HIGH SCHOOLS

Source of Variation	Sum of Squares of Errors of Estimate	Degrees of Freedom	Mean Square	F Ratio	F needed at 5% Level
Total	67.99	248			
Within groups	57.89	244	.237		
Adjusted means	10.10	4	2.525	10.65	2.41

schools whose contribution to between variance was largest, three schools (schools 1, 3, 4) finally were selected in which grade point

averages were not significantly different (with the exception of one subject area). The results of the analyses among the three remaining schools are shown in Table 7, by subject area. In general, random samples of the scores of fifty students from each school were used in the analyses. In three areas, however, (Language, Home Economics, and Industrial Arts) the number of students selecting these majors was less than fifty. In such cases, the lowest number of scores represented by any one school was used, and a similar number of scores was chosen randomly from the remaining two schools. In one case, Business Education, a random sample of sixty scores from each school was used for the analysis.

By inspection of Table 7, only one of the analyses met the standard of significance set, namely grade point averages in mathematics. All of the remaining analyses confirmed the null hypothesis. Why grade point averages in mathematics were significantly different is not known. Perhaps the particularly harsh or lenient marking practices of one teacher are responsible for the difference. Because of this discrepancy, the pooled subjects in only two schools (school 1 and 4) were used for the prediction of grades in mathematics. The F-ratio derived from the analysis of covariance of these two schools was 2.21, while that needed for significance at the five per cent level of confidence was 3.94. The degrees of freedom for this evaluation were 1 and 97.

It is an interesting fact that on the whole, the marking practices among these three schools, in their respective subject areas, is strikingly similar when due adjustment is made for levels of scholastic ability. It is worthy of note that these three schools are among the

TABLE 7

ANALYSIS OF COVARIANCE OF TOTAL AND SUBJECT AREA GRADE POINT AVERAGES ADJUSTING THESE MEANS FOR LEVELS OF SCHOLASTIC ABILITY IN THREE CINCINNATI HIGH SCHOOLS

Source of Variation	Sum of Squares of Errors of Estimate	Degrees of Freedom	Mean Square	F Ratio	F needed at 5% Level
Total Grade Point Average					
Total	33.66	148			
Within groups	32.82	146	.225		
Adjusted means	.84	2	.420	1.86	3.06
Business Education Grade Point Average					
Total	22.00	178			
Within groups	21.35	176	.121		
Adjusted means	.65	2	.325	2.68	3.05
English Grade Point Average					
Total	55.80	148			
Within groups	53.97	146	.369		
Adjusted means	1.83	2	.915	2.48	3.06
Language Grade Point Average					
Total	25.32	61			
Within groups	24.42	59	.413		
Adjusted means	.90	2	.450	1.08	3.15
Home Economics Grade Point Average					
Total	11.32	34			
Within groups	10.14	32	.311		
Adjusted means	.90	2	.450	1.08	3.15

TABLE 7 (continued)

Industrial Arts Grade Point Average					
Total	20.59	58			
Within groups	20.32	56	.362		
Adjusted means	1.27	2	.135	.36	3.15
Mathematics Grade Point Average					
Total	69.41	148			
Within groups	57.82	146	.389		
Adjusted means	11.59	2	5.795	14.84	2.06
Science Grade Point Average					
Total	46.77	148			
Within groups	44.94	146	.307		
Adjusted means	1.83	2	.915	2.98	3.06
Social Studies Grade Point Average					
Total	46.99	148			
Within groups	45.95	146	.314		
Adjusted means	1.04	2	.520	1.67	3.06

oldest schools in the Cincinnati system. It is likely that the teaching personnel comprising these schools represent the older and more well-established teachers in the system. If this be the case, it may well be suspected that their similarity is due to the longer periods of interaction between the teachers in these schools. Informal exchanges of marking practices may have led to the homogeneity observed.

On the basis of these analyses then, the pooled twelfth grade students from these three separate high schools comprise the subjects used in the remainder of this investigation. The total number thus

derived was 595 students made up of 329 girls, and 266 boys.

II. SOURCES OF DATA

The method of selecting the high schools used in this study was described in the preceding section of this chapter. The total number of students comprising the senior classes of these schools, however, was not included in this study. The method of selecting the experimental group was simple; only students who had taken all of the standardized tests used in this study were included. This final group consisted of a total of 595 students.

Source of test data. The testing instruments used were administered to the students comprising this study on the following dates:

1. Differential Aptitude Test Sub-tests - February, 1953
2. (Metropolitan) English Proficiency Test - March, 1953
3. (Metropolitan) Mathematics Proficiency Test - March, 1953
4. Terman-McNemar Test of Mental Ability - September, 1953
5. American Council on Education Psychological Examination February, 1956
6. Essential High School Content Battery - May, 1956

With the exception of the English and Mathematics Proficiency Tests, all tests were administered by trained examiners from the Division of Appraisal Services, Department of Instruction, Cincinnati Public Schools. The tests were scored, checked, and recorded by personnel trained for this purpose. Summary sheets of test score data were then typed and sent to the respective schools. It is from these data sheets, that the test data were obtained. All test scores were sent back to the

schools except the Differential Aptitude Test results which were considered experimental in nature.

Source of grade point averages. After all the test data were recorded on large tabulation sheets, students who had not taken all of the tests were immediately rejected for further study. The names of the remaining group were then used to look up the course marks for each student. The grades were obtained from the office records of the respective schools. These office records include not only the course grades but also indicate the student's high school majors. In some instances, students were completing (or had completed) a major which was not recorded on the office records. For this reason, care was taken to peruse the courses taken for further identification of student majors. When three or more one-unit courses were found in any of the subject matter areas studied, the grades from these courses were recorded. The results of averaging these and reducing them (if necessary) to a four-point scale represent the final grade point averages used.

Review of tests used. The tests used in this study not only include predictor tests but also an achievement battery, the Essential High School Content Battery, used as an alternate criterion of scholastic success, and a scholastic aptitude test, the American Council on Education Psychological Examination, used as a basis for the covariance analysis described in the previous section. The predictor tests are as follows: four sub-tests from the Differential Aptitude Battery, i.e. Verbal Reasoning, Numerical Ability, Mechanical Reasoning, and Language Usage, (made up of two sub-tests, Spelling and Sentences); the Terman-McNemar Test of Mental Ability; and an English and

Mathematics Proficiency Test. The predictor tests thus include measures of special and general aptitude as well as two measures of past accomplishment.

A more detailed description of each of the tests listed above will now be made.

A. The Differential Aptitude Tests

1. General purpose. The general purpose of this battery is to "provide an integrated, scientific, and well standardized procedure for measuring the abilities of boys and girls in grades eight through twelve for purposes of educational and vocational guidance."[1]

2. Description. These tests were administered during January and February, 1953 to all pupils in grade eight of the Cincinnati Public Schools. The pupils of this class now represent the current (1956-57) senior class. The description of each test given to this class is as follows:

> Verbal Reasoning: This test is composed of simple analogies. The words used inthe items come from history, geography, literature, science, and other content areas. The items are intended to sample the student's knowledge and his ability to abstract and generalize relationships inherent in that knowledge.

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[1]George K. Bennett, Harold G. Seashore, Alexander G. Wesman, Differential Aptitude Tests, Manual-Second Edition (New York: The Psychological Corporation, 1952), p.1.

Numerical Ability: The items on this test are designed to test understanding of numerical relationships and facility in handling numerical concepts. The problems are of the type usually called "arithmetic computation" rather than the "arithmetic reasoning" type. The items were set up in this manner to avoid the language elements of the usual arithmetic reasoning problem, in which reading ability may play a significant role. Actual try-out of the test in its preliminary form, however, demonstrated that the items are so constructed that the measurement of reasoning ability is not sacrificed by the use of the computation type.

Mechanical Reasoning: This test is essentially a new form of the series of Mechanical Comprehension Tests used widely by industry and the military. Each item consists of a pictorially presented mechanical situation together with a simply worded question. Care was taken to present items in terms of simple, frequently encountered mechanisms that do not resemble textbook illustrations or require special knowledge. It should be noted that the authors of the Differential Aptitude Test Battery consider the Mechanical Reasoning scores of less educational and vocational significance for girls than for boys.

Spelling: The spelling words were selected from the lists in the Gate's Spelling Difficulties in 3876 Words, then further selected for their prominance in every day vocabulary.

Sentences: This section of the test is designed to measure the student's ability to distinguish between good and bad grammar, punctuation and word usage. It should be noted that Sentences and Spelling are more nearly achievement tests than any of the others. Their chief reason for being included in the battery is that it is believed that they represent basic skills necessary in many vocational pursuits.

3. Reliability. The authors of these tests present an elaborate array of statistical data including numerous reliability coefficients. Since reliability is a function of the group on whom it was established, the authors present separate coefficients for each sex by grade level. These reliability coefficients appear sufficiently high to accept the long range consistency of the scores.

4. Validity. It is better to speak of the validities of the Differential Aptitude Test since the number of validity coefficients is momentous, being derived from a great variety of situations using varying criteria. The particular types of validity, with which this study is concerned, have been summarized in the chapter reviewing the literature as prediction of course grades and prediction of achievement test results.

B. The Terman-McNemar Tests of Mental Ability

1. General purpose. It is the general purpose of this test to attempt to measure those aspects of intelligence which are

considered verbal in nature. It does not profess to measure "performance" or "qualitative" aspects of intelligence.

2. Description. This test represents a revision and restandardization of the Terman Group Test of Mental Ability. The test consists of 162 items arranged in seven sub-tests; Information, Synonyms, Logical Selection, Classification, Analogies, Opposites and Best Answer. Because the arithmetical and numerical subtests used in the original forms have been taken out, the test is primarily a general verbal intelligence test. Since the number of items in each sub-test is small, no separate norms are presented. Data are available to interpret the resulting total raw score in terms of normalized standard scores, mental ages, percentile ranks, and "deviation I.Q.". The deviation I.Q. was the particular score used in this study. It is simply the differences between the obtained standard score and the average standard score for other individuals of the same age.

3. Reliability. Three methods of determining the reliability of this instrument were employed. The split-half method produced a coefficient of .96 when determined on 279 cases in grades seven through nine. The alternate form method showed a coefficient of .95, being computed on 239 cases in grades seven through nine. The probable error of measurement of this test is about 2.2 standard score points.

4. Validity. According to the manual for this test, "the best

evidence of the validity of the Terman Test is to be found in its successful use over the period of years since the test was first used."[2] One type of validity evidence is presented, however, through the careful and comprehensive item analysis done on the test. Items were chosen which successfully differentiated groups of different maturity levels (as indicated by grade level). In addition, an internal type of validity is evidenced by an average item-test tetrachoric correlation of .53.

C. The English Proficiency Test.

1. General purpose. The authors of the achievement battery of which this test is a part assert, "The separate subject-matter tests comprising these batteries provide reliable measures of individual achievement." They say further that a major use of the tests is, "to determine the achievement level of each pupil in each subject... To provide an objective and reliable basis for classification and grouping for instructional purposes."[3]

2. Description. This test is a special edition published for the Cincinnati Public Schools by the World Book Company. It is composed of three sub-tests from the Metropolitan Achievement

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[2]Lewis M. Terman and Quinn McNemar, "Construction of the Tests," Terman-McNemar Test of Mental Ability (New York: The World Book Company, 1942), p.3.

[3]Richard D. Allen, Harold H. Bixler, et al., "Content of the Series," Metropolitan Achievement Tests Intermediate and Advanced Arithmetic Tests (New York: The World Book Company, 1947), p.1.

Tests, Advanced Battery, Partial: Form R. These sub-tests are Reading, Vocabulary, and Spelling. The reading sub-test consists of 52 items which attempt to measure "paragraph meaning" and "word meaning." The vocabulary test consists of 55 items which in general require the student to mark a word meaning the same as a key word. The Spelling Test consists of 50 items which are read to the examinee. The sum of the raw scores of these sub-tests represents the English Proficiency Test score used in this study.

3. Reliability. The manual for the Metropolitan Achievement Tests reports the following split-half reliability coefficients corrected by the Spearman-Brown formula: Reading - .937, Vocabulary - .924, and Spelling - .943. These coefficients were computed on raw scores from 280 seventh graders.

4. Validity. The type of validity associated with this test (as well as other sub-tests of the battery) is often termed "curricular" or "content" validity. The items are representative of courses of study, textbooks, and the opinions of experts in the field.

D. The Mathematics Proficiency Test

1. General purpose. The purpose of this test is similar to that described for the English Proficiency Test except, of course, that this instrument attempts to measure achievement in arithmetic.

2. Description. This test is also a sub-test of the Metropolitan

Achievement Battery, Advanced Arithmetic Test, Form R. The name "Mathematics Proficiency" is a local term, since the same mathematics achievement test is not given every year. This name will be used throughout this study. The test consists of two parts, Arithmetic Fundamentals and Arithmetic Problems. The former consists of 57 items which measure essentially computational skills, while the latter consists of 33 items commonly described as "story" or "word" problems. The sum of the two raw scores of these sub-tests represents the Mathematics Proficiency scores used in this study.

3. Reliability. The manual gives the following corrected split-half reliability coefficients computed from the raw scores of 280 seventh graders: Arithmetic Fundamentals, .914 and Arithmetic Problems, .879.

4. Validity. The validity of this test is similar to the type described for the English Proficiency Test.

E. The American Council on Education Psychological Examination (1947 high school edition)

1. General purpose. The purpose of this test is to measure the learning ability or scholastic aptitude of students in grades nine through twelve.[4]

2. Description. The American Council on Education Psychological

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[4]American Council on Education, Manual of Directions, Tables of Equivalent Scores and Percentile Ranks (Princeton, New Jersey).

Examination is composed of four sub-tests: Same-Opposite, Completion, Arithmetic and Number Series. The composite score of the first two sub-tests represents the linguistic score, while the latter two sub-tests represent the quantitative score. The differentiation between the quantitative and linguistic abilities was the result of factor analysis demonstrating these two basic factors. The total score for the entire test indicates general scholastic ability. For use in this study, the American Council on Education Test served as a basis for adjusting criterion means for varying levels of scholastic ability among schools, in order to determine the comparability of grade point averages from school to school. The combined total of the L and Q raw scores served for this purpose.

3. Reliability. The reliability of this test is estimated by its correlation with an equated form of the American Council on Education Examination and the test itself. This adaptation of a test-retest procedure gave reliability coefficients of .894 and .931 for ninth grade (N 302) and twelfth grade (N 264) populations respectively. The corresponding standard errors of measurements are 6.14 and 6.33.

4. Validity. The validity of this test is based primarily on the relevance of the material to scholastic aptitude and the similarity of test content to others which have been validated in various school systems.

F. The Essential High School Content Battery (EHSCB)

1. General purpose. In their manual of directions, the authors of this battery of tests state that this battery is,"a comprehensive battery of high school achievement tests covering in a single booklet, four basic areas--mathematics, science, social studies, and English. The battery is designed for use as a survey-type instrument from the end of the ninth through the end of the twelfth grade."[5] A further purpose is to measure the students' growth and development in the four areas mentioned above.

2. The Essential High School Content Battery, for purposes of this study, serves as a supplementary criterion of success in each of the areas of subject matter it attempts to measure. The total score on the battery also serves as a supplementary criterion for total grade point average or general academic success. This battery was administered at the end of grade eleven to the current senior class. Since this battery is composed of four separate sub-tests, each one will be described in turn. The table of norms provides for the direct conversion of raw scores into standard scores for each of the sub-tests.

Mathematics - This test samples arithmetic skills, general mathematics, algebra, geometry and to some degree

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[5]David P. Harry and Walter N. Durost, "Manual of Directions" Essential High School Content Battery (New York: The World Book Company, 1951), p.1.

trigonometry and advanced algebra. The author describes the emphasis as being on "content having social utility, and on understandings rather than manipulative skills."[6] The sub-test is composed of sixty-six items being divided into eight sub-parts as follows: fundamental skills in computation, vocabulary and concepts, understanding of functional relationships, application of mathematics to life problems, interpretation of mathematical graphs, knowledge of mathematical facts and formulas, interpretation of data in tabular form, and knowledge of important theorems.

Science - The science sub-test is made up of three parts: Part A measures functional knowledge of factual material, Part B measures the understanding and application of scientific principles and concepts, and Part C measures the application and understanding of methods of science. The items in the above parts tap content in both the physical and biological sciences. The total sub-test consists of seventy items.

Social Studies - The content areas covered by this sub-test include American History, World History, Civics and Government, Economics and Problems of Democracy. On the whole, however, it measures factual knowledge in the field of social studies. This sub-test has a total of ninety items being distributed over ten sub-parts as follows: acquaintance with

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[6] Ibid., p.2.

contributions of famous Americans, understanding of current social and political problems, understanding of vocabulary of social studies, knowledge of civic information, growth of American democracy, knowledge and understanding of global geography, knowledge of contributions of world leaders, understanding of international relationships, knowledge of the sequence of events in United States history, and knowledge of world events.

English - This sub-test includes measurement in the following areas: understanding of the written language, precision in the use of English, acquaintance with literary works, and knowledge of reference sources. The sections of the sub-test measuring these areas are as follows: reading for information, vocabulary, business definitions, use of references, literature acquaintance, language usage, capitalization and punctuation and spelling. The total sub-test contains 120 items.

3. Reliability. The reliability of the E.H.S.C.B. has been indicated in three ways: by use of the split-half method, the alternate forms method and by use of the standard error of measurement. A partial reproduction of the reliability table (6a) in the E.H.S.C.B. manual (for grade 11 only) is shown in Table 8.

4. Validity. The manual states evidence of the validity of the

E.H.S.C.B. in essentially two ways. The first type is commonly called "curricular" validity. The authors made intensive analyses of typical offerings in the various areas of subject matter as well as analyses of textbooks for the determination of test content. The second type of validity is called item validity. Presumably, item-test correlations were used as indices of item validity.

TABLE 8

SPLIT-HALF AND ALTERNATE FORM RELIABILITY COEFFICIENTS, BY SEPARATE GRADE LEVELS

Test	N	rAB	r11	S.E. Meas.
Mathematics	101	.92	.93	4.2
Science	268	.78	.89	3.8
Social Studies	151	.87	.90	4.1
English	181	.87	.90	3.0
Total Battery	113		.95	2.7

CHAPTER IV

METHODS AND PROCEDURES

I. THE TYPES OF TESTS USED IN THE STUDY

The types of instruments used in the prediction of attributes depends, of course, upon the nature of the attributes themselves.Among the types of tests used most commonly in the prediction of academic achievement are so-called intelligence, achievement, and aptitude tests. In a recent publication of the Test Service Bulletin, however, the authors point out that discrimination among these three types of tests cannot be on the basis of content or process since they are basically similar in all three types of tests. The authors state further that in terms of differentiating these types...

> A logical candidate would seem to be function. What are we trying to accomplish with the test scores? How are the results to be used? What inferences are to be drawn concerning the examinee? If a test's function is to record present or past accomplishment, what is measured may be called achievement. If we wish to make inferences concerning future learning, what is measured is thought of as aptitude. One kind of aptitude test, usually some combination of verbal and numerical and/or abstract reasoning measures, is sometimes called an intelligence test; more properly, in educational settings, it is called a scholastic aptitude test.[1]

Since the purpose of this study is to evaluate certain tests for their ability to predict academic success, the complexity of the predicted attributes warrants the evlauation of the three types of instruments, since the prediction of future achievement is dependent not only

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[1]Harold G. Seashore, "Aptitude, Intelligence, and Achievement," Test Service Bulletin, No. 51 (New York: The Psychological Corporation, 1956), p.1.

upon academic aptitude but also upon past accomplishment. Rather than make armchair speculations as to the nature of the mental abilities needed for success in each of the subject areas, it is better to secure empirical evidence.

For this study, two measures of achievement (past accomplishment) are used, i.e. the English Proficiency Test and the Mathematics Proficiency Test. The Verbal Reasoning, Numerical Ability, Mechanical Reasoning, Spelling, and Sentences Tests of the Differential Aptitude Battery represent five measures of "special" abilities or aptitudes. The measure of general scholastic aptitude used in the study is the Terman-McNemar Tests of Mental Ability.

In an attempt to discover the mental abilities needed for success in the various subject areas, it is recognized that paper and pencil tests measuring mental traits have a high degree of inter-correlation. This fact acts against the possibility of isolating certain mental traits needed for success. For a test to make a worth while contribution to a testing program, it must either do a better job of performing the functions than another test, or add to the performance of the function. Before a test can add something which is not already being measured by another test, it must obviously be independent of any high relationship with the existing test. Although one of the major purposes of this study is to determine which tests show the highest relationships with the criteria, it also is intended to isolate the differential abilities, if any, that are being measured by the seven tests used and that are needed also for success in various subject areas.

II. TREATMENT OF RAW DATA

Before proceeding with an explanation of how the raw data were treated, it may be well to state what form the raw data were in before treatment. The scores used in this study were in the same form as they were found and recorded from the original records. The types of scores used for each of the tests are seen in Table 9.

TABLE 9

TYPES OF SCORES USED FOR EACH OF THE PREDICTOR TESTS

Test	Types of Scores
Differential Aptitude Tests	Raw Score
English Proficiency Test	Raw Score
Mathematics Proficiency Test	Raw Score
Terman-McNemar Tests of Mental Ability	I.Q. Score
A.C.E. Psychological Examination	Raw Score
Essential High School Content Battery	Standard Score

After the raw data had been recorded on large tabulation sheets, and each student given a four digit code number for personal and school identification, the International Business Machines Service Bureau was commissioned to punch IBM cards for each student with the appropriate information from the original data sheets. All card punching was verified.

With the generous help of the Applied Science Division of the International Business Machines Corporation, it was decided to utilize

a "ready-made" library program which would provide the means, standard deviations, and inter-correlations between all the variables used. The IBM data were then gang punched into the format necessary for this program. The actual processing of the data was done by IBM's Magnetic Drum Data Processing Machine, commonly called the 650.

Initially, the students comprising this study were separated by sex. The two resulting groups were then processed for the procurement of the data necessary for the prediction of total grade point average and the grade point average in English (since the total group of students must have had a major in English). From these two groups, social studies majors then were sorted out and the necessary data again computed for this group. Each major was sorted out in turn, until all majors had been processed. It should be mentioned that the data thus derived are extremely accurate. The library program used provided for checks which indicate errors which may occur. The final data could not be punched out of the 650 until the detected errors (if any) were corrected.

III. STATISTICAL METHODS AND PROCEDURES

The coefficient of correlation. The index of relationship used in this study is the Pearson product-moment coefficient of correlation. As such, it is well to take cognizance of the statement and illustration given by Guilford:

> A correlation is always relative to the situation under which it is obtained, and its size does not represent any absolute natural or cosmic fact. To speak of the correlation between intelligence and scholarship,is absurd. One needs to say which intelligence, measured under what circumstances, in what population, and to say what kind of scholarship, measured by what instruments,or judged by what standards. Always, the coefficient of correlation is purely relative

> to the circumstances under which it was obtained and should be interpreted in the light of those circumstances; never certainly, in any absolute sense.[2]

As applied to this study, it must be remembered that the group used in this study is a selected group, by virtue of the fact that they have attained the status of high school senior. This automatically eliminates the great heterogeneity one finds at the eighth grade level, which of course, is the point at which the prediction of this study is being attempted. In addition to this fact, further selection takes place on the basis of high school majors. Each group thus isolated represents a much more homogeneous group than the total group. It is to be expected, therefore, that correlations found within sub-groups will be of a lower magnitude than those found for the total group.

Methods of achieving multiple prediction. All of the direct predictions of success were computed using zero order correlations. In addition to the simple correlations between the predictors and the criteria, multiple predictions were also made which resulted in the multiple correlation coefficient and the multiple regression equation. The method used for determining the regression weights was that described by Thorndike.[3] This is an abbreviated Doolittle solution. The standard partial regression weights were checked for accuracy by means of the following equation:

$$B_{12}r_{2n}\ B_{13}r_{3n}\ B_{14}r_{4n}\cdots\cdots\ r_{1n}\ ^{4}$$

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[2]J.P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, 1942), p. 220.

[3]Robert L. Thorndike, Personnel Selection (New York: John Wiley and Sons, Inc., 1949), pp. 336-339.

[4]Guilford, op. cit., p. 393.

where 1 represents the criterion; 2,3,4, etc., represent the predictor variables; and "n" represents the last predictor variable. After this was done, the "b" coefficients were computed along with the constant "a", and finally the complete regression equation was written.

The sets of inter-correlations among the predictors used in all the multiple regression analyses in this study were those derived from the total group of boys and the total group of girls. Thus the sets of inter-correlations found after the groups had been selected by major, were not used. Once selection has occured, the inter-correlations would decrease in magnitude because of the greater degree of homogeneity. The significance of this fact is great, since it means the inter-correlations among the variables are at their maximum because of the greater degree of heterogeneity. As such, the magnitude of the multiple correlations are necessarily less than they would be if the "selected" group inter-correlations were utilized.

The reason for this decision is simply that prediction is being attempted at the eighth grade level where the group of students are as yet un-differentiated as to the selection of their high school majors. To use the inter-correlations of the predictors derived from the selected groups would presume the eighth grade population to be differentiated already with respect to high school major which, of course, is not the case.

By inspection of the products of the beta weights of each predictor variable with its corresponding correlation with the criterion, the two predictors of grade point averages with the highest product (and lowest inter-correlations) were used together to predict the

criterion. The multiple correlation for three variables was computed by use of the following equation:

$$R^2 = \frac{r_{12}^2 + r_{13}^2 - 2r_{12}\, r_{13}\, r_{23}}{1 - r_{23}^2} \qquad (5)$$

The latter equation, based on the two best predictors of the criterion, was written primarily on the grounds of practicality. Counselors would find it indeed difficult to manipulate the longer regression equation for each counselee especially when he is responsible for helping a large number of students. To simplify further prediction, a nomograph was constructed to represent the regression and provide the prediction of grade point average through simple reading of the graph.

Multiple prediction of the alternate criterion, i.e. the Essential High School Content Battery, was achieved by selecting the two predictors with the highest correlation with the criterion and the lowest inter-correlation. The method previously described for computing multiple R for three variables was used. The resulting equations for the prediction of boys' and girls' composite score on the EHSCB were graphed along with the prediction of total grade point averages as criteria of general academic success.

Methods of differentiating groups. As stated previously, the primary method of differentiating groups was on the basis of sex and high school major. The major reasons for differentiating groups by sex are first, boys and girls tend to elect certain course selections

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[5] Ibid., p. 393.

differentially. Secondly, since validity is specific to the criterion, and since the criteria may be different between the sexes, it is necessary to separate sex groups. Finally, it is likely the various abilities needed for success would be different for boys and girls.[6]

The purpose of differentiating groups constituting subject areas is to determine whether the abilities needed for success in one subject area are different from those needed for success in another subject area. In other words, can differential prediction be made? If there is no differential prediction, i.e. the abilities needed for success are similar in all subject areas, than it would be possible to achieve the optimal prediction using those predictors which measure the abilities common to all subject areas. If this were the case, it would not mean that differential prediction among subject areas is not possible. Certain required abilities may be common to all subject areas, but there also may be other abilities not measured in this study which could possibly differentiate subject area groups.

For purposes of comparison, it is necessary not only to differentiate groups by sex and subject area, but it is also necessary to differentiate the successful student from the unsuccessful student within any given subject area. This would be done to determine quantitatively which abilities the successful group possessed to a greater extent than the unsuccessful group. Since there is no absolute measure of success in any single course or group of courses, its total

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[6]Alexander Wesman, "Separation of Sex Groups in Test Reporting," Journal of Educational Psychology, 40:228, April, 1949.

measurement is impossible. Arbitrary standards such as grades, however, can be set up and "success" and "failure" must be interpreted in light of the arbitrary standards which grades reflect.

Even within the realm of grades, what constitutes success or failure? Does the achievement of an "A" represent success, or will a "B" suffice? Here again, operational definition is necessary because teachers' grades depend, among other things, on the range of talent found in the classroom. For example, in a class of very capable pupils, the average pupil (who may receive a grade of "C") would be superior to many members of another class whose over-all caliber may be lower.

Another standard for success could be defined simply as passing a course. From this point of view, any student achieving senior status with the required number of majors must be a success in his majors; that is, he must have passed certain courses in a subject area in order to fulfill the requirements for a major. One could assume, therefore, that the students majoring in any given subject area possess the abilities needed for success in that area to a greater extent than do students not majoring in that area. This statement is predicated on the assumption that there is a unique combination of abilities needed for success in each subject area. If this is found to be unwarranted, insofar as the abilities measured by the predictors are concerned, and that rather, success is based on a general common factor or factors, then one would suspect that students who possess a large amount of the common factors could also be successful in a subject area they did not choose to major in. Even if the assumption is found to be warranted, one cannot know whether a student would have been successful in a major

had he selected it.

With these limitations in view, one method of determining differences is to compare the performance on each predictor variable for each group comprising a major with the remaining group. Science majors, for example, were compared with non-science majors. Statistical tests for the significance of difference between means have been made between the two groups for each predictor variable.

It cannot be over emphasized, that the latter approach is primarily one of description rather than prediction. Suppose, for example, the science majors were found to have a significantly higher I.Q. than the non-science majors. From this, it does not follow that to be successful as a science major one must have a high I.Q. or to have a high I.Q. means that one would be successful as a science major. Evidence of this type is indirect and inferential, since, to reiterate, one does not know whether the non-majors in a subject area would have been successful had they majored in that area.

Other statistical procedures used in this study. Three other statistical procedures used bear mentioning. The first involves the procedure for determining the significance of difference between correlation coefficients. When this was done, the coefficients were converted to their respective "z" functions. The standard error of the difference between the "z's" was then computed and divided into the difference of the two "z" functions.

The second procedure commonly used was in averaging correlation coefficients. This was done by first converting each correlation into its appropriate "z" function, averaging the "z's", and re-converting the

average "z" to the correlation coefficient.

The third technique used was an application of the well-known Student's "t" test. This test was used for determining the significance of difference between means. Since the groups on whom comparisons were made were independent, no correction for correlated means was needed.

Chapter V and VI will now present the analysis and interpretation of the findings of this study.

CHAPTER V

THE DIRECT AND MULTIPLE PREDICTION OF GENERAL HIGH SCHOOL ACADEMIC SUCCESS

I. THE DIRECT PREDICTION OF TOTAL GRADE POINT AVERAGE AND THE COMPOSITE SCORE OF THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY

The prediction of general academic success using total grade point average as the criterion is a highly complicated matter. The criterion itself represents a combination of many varied courses taught by many different teachers whose standards in grading more than likely lack uniformity. As a matter of fact, even though teachers of different subjects made a concerted effort to grade uniformily, it is doubtful whether any great degree of uniformity could be achieved. The varying types of subject matter being dealt with, the varying objectives of the courses, and the various abilities needed to achieve success contribute to this lack of uniformity.

Even in the light of the aforementioned weaknesses of using total grade point averages as criteria of general academic success, it is an important factor for evaluation. Prediction of general academic success may result in the early identification of potential drop-outs. Mitchell[1] found, for example, that high school pupils scoring in the middle fifth of the class on an I.Q. test administered upon entering high school, have three times as many chances of remaining in high school until they finish as one who scores in the lower fifth; pupils

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[1]Claude Mitchell, "Prognostic Value of Intelligence Tests," Journal of Educational Research, 28:577-581, April, 1935.

in the upper fifth had twenty-one times as many chances of remaining as those in the lower fifth.

High school administrators also use total grade point averages for determining class rank, which in turn is a consideration used by colleges and universities for entrance. The Essential High School Content Battery composite score represents a more objective and uniform criterion of academic success in the tool subjects.

Predictive information of these criteria may also prove useful in the guidance process. If very low prognostication is made in a given case, for example, a counselor may support a student's view of leaving school and entering into a vocation where his chances for success are greater.

Direct prediction of total grade point average. The degree of relationship between each aptitude and achievement test predictor used and the total grade point average is seen in Table 10. It will be noticed that separate predictions are made for each sex. This type of analysis will be used in all of the foregoing predictions.

Considering the complexity of the criterion, the relationships shown in Table 10 are rather high, particularly between the Mathematics Proficiency, Numerical Ability, and the Terman-McNemar predictors with the criterion. For both boys and girls, these three tests correlated highest with the total grade point average criterion. For boys, the correlations ranged from .310 to .657 while for girls, the range was between .437 and .716. For both boys and girls, the Mechanical Reasoning Test provided the lowest correlation with the criterion while the Terman-McNemar Intelligence Test provided the highest correlation with

TABLE 10

CORRELATIONS BETWEEN THE PREDICTOR VARIABLES AND TOTAL GRADE POINT AVERAGE, AND THE SIGNIFICANCE OF DIFFERENCE OF THE CORRELATIONS BETWEEN BOYS AND GIRLS

Predictor Variable	Boys (N=266)	Girls (N=329)	z
Verbal Reasoning	.510	.596	1.473
Numerical Ability	.613	.686	1.461
Mechanical Reasoning	.310	.437	1.751
Spelling	.438	.582	2.294*
Sentences	.544	.588	.809
Terman-McNemar Intelligence	.582	.661	1.582
English Proficiency	.539	.638	1.859
Mathematics Proficiency	.657	.716	1.365

* Significant at the five per cent level of confidence.

the criteria.

Another important aspect of Table 10 is the consistently higher relationships existing between the predictor test variables and the criterion variable for girls than for boys. In no case are the correlations higher for boys. In only one case, however, that of the Spelling Test, is the correlation significantly higher than chance would allow. In addition, it will be noticed that a ranking of these "validity" coefficients for girls and boys results in a very similar ordering. Since these data were arrived at independently, the latter fact lends to an acceptance of the statistics as reliable measures of the relationships.

In regard to the higher relationships among girls, a very probable explanation lies in the fact that the boys represent a much more homogeneous group than do the girls. Since correlation is a function of group variability, the correlation would be expected to be higher among girls than among boys. This is probably due, at least in part, to the greater number of drop-outs among boys than among girls. Since these drop-outs largely are among the boys of lower academic caliber,[2] the remaining group is not only relatively homogeneous but also represents the academically better students. These tendencies are shown in Table 11, where the means and standard deviations together with the significance of difference between the means for boys and girls, are shown.

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[2]Lee J. Cronbach, Educational Psychology (New York: Harcourt, Brace and Company, 1954), p. 193.

TABLE 11

MEANS, STANDARD DEVIATIONS, AND THE SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS FOR THE TOTAL GRADE POINT AVERAGE AND THE PREDICTOR VARIABLES BETWEEN BOYS AND GIRLS

Variable	Sex	N	Mean	t-ratio	Standard Deviation
Verbal Reasoning	Boys	266	16.39	.67	7.53
	Girls	329	15.96		7.99
Numerical Ability	Boys	266	16.00	2.53*	6.66
	Girls	329	14.59		6.88
Mechanical Reasoning	Boys	266	35.38	13.38**	11.59
	Girls	329	23.11		10.49
Spelling	Boys	266	25.44	4.31**	21.03
	Girls	329	33.53		24.62
Sentences	Boys	266	19.94	4.21**	12.78
	Girls	329	24.47		13.36
Terman-McNemar Intelligence	Boys	266	109.98	1.95	13.44
	Girls	329	107.72		14.75
English Proficiency	Boys	266	100.95	1.65	22.08
	Girls	329	104.05		23.71
Mathematics Proficiency	Boys	266	58.44	2.80**	17.00
	Girls	329	54.42		17.85
Total Grade Point Average	Boys	266	2.24	2.53*	.60
	Girls	329	2.37		.65

* Significant at the five per cent level of confidence.
** Significant at the one per cent level of confidence.

Inspection of Table 11 shows that with the exception of the Mechanical Reasoning Test, which would be expected to be more variable for boys than for girls by virtue of the nature of the test itself, the girls tend to be a more variable group.

The mean test scores of boys exceeds that of girls for the Verbal Reasoning, Numerical Ability, Mechanical Reasoning, Terman-McNemar Intelligence, and the Mathematics Proficiency Tests. The differences between the Verbal Reasoning and Terman-McNemar Intelligence Tests, however, were not statistically significant. The mean differences favoring the girls were found on the Spelling, Sentences and English Proficiency Tests. Of these, only the English Proficiency Test means proved to be not significantly different from zero. In general, it seems the test predictors in which boys score higher may be classified as quantitative abilities while those predictors on which girls score higher are apparently of a more linguistic nature.

It is interesting to note that although the Mathematics Proficiency Test is the best single predictor of general academic success, and although boys achieved higher on this variable than did the girls, nevertheless the girls achieved a significantly higher mean total grade point average than did the boys. This difference is seen to be significant at the five per cent level of confidence. This discrepancy suggests that grades are based not only upon the nature of academic abilities, but also upon other aspects of pupil behavior probably centering around that area often designated as behavior. The fact that boys tend to be "problem" children more than girls may possibly be a factor in their lower grades. Another explanation lies in the nature of the

criterion itself. Since the total grade point average represents an average of all one-unit courses taken by the student in high school, it obviously becomes dependent upon the type of curricula the students enter. Thus, if boys enter into more demanding curricula than girls, this could be reflected in the lower mean grade point average.

Direct prediction of the Essential High School Content Battery Criterion. The probable biases in grading practices suggested in the latter section can be overcome through the use of an objective measure of achievement, i.e. the composite score of the Essential High School Content Battery (EHSCB). The differences between these two criteria should not be overlooked. Whereas the total grade point average is an over-all average of all one-unit courses taken in high school, the composite score of the EHSCB represents an over-all average score of performance on each of its sub-tests, i.e. mathematics, science, social studies and English. The total grade point average is, therefore, a much more complex and inclusive composite of performance than the EHSCB criterion. The latter is more a composite of the "fundamental"or "tool" academic subjects.

The correlations of the test predictors with this criterion are shown in Table 12 along with the "z" ratio indicating the significance of difference of the correlations between boys and girls.

Again it is seen without exception, that the correlations are higher among girls than among boys. In only two instances, however, are the differences significant, namely for the Spelling and the Terman predictors. The best three predictors are seen to be the Terman, English Proficiency, and Mathematics Proficiency Tests for both boys and girls.

TABLE 12

CORRELATIONS BETWEEN THE PREDICTOR VARIABLES AND THE COMPOSITE SCORE OF THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY TOGETHER WITH THE SIGNIFICANCE OF DIFFERENCE OF THE CORRELATIONS BETWEEN BOYS AND GIRLS

Predictor Variable	Boys (N=266)	Girls (N=329)	z
Verbal Reasoning	.700	.741	1.002
Numerical Ability	.644	.703	1.328
Mechanical Reasoning	.455	.557	1.630
Spelling	.562	.670	2.149*
Sentences	.662	.687	.543
Terman-McNemar Intelligence	.803	.858	2.174*
English Proficiency	.732	.788	1.715
Mathematics Proficiency	.709	.750	1.139

* Significant at the five per cent level of confidence.

It is interesting to note the fact that the best two predictors of total grade point average (the Terman and the Mathematics Proficiency Tests) are also two of the best three predictors of the EHSCB criterion. In comparing the prediction of both criteria, it is seen that the English Proficiency Test has replaced the Numerical Ability Test as the third best predictor. Even in view of this fact, the data suggest that the EHSCB criterion is fairly consistent with the total grade point average criterion. This idea is partially borne out by the correlations between these two criteria; for boys, $r=.744\pm.028$ and for girls $r=.765\pm.023$. Considering the differences in these two criteria, the relationship is remarkably high.

For boys, the correlations range from .455 to .803, while for girls the correlations range from .557 to .858. For both boys and girls, the highest correlation with the criterion was provided by the Terman-McNemar Test and the lowest correlation was provided by the Mechanical Reasoning Test. On the whole, it seems that the Differential Aptitude Test predictors are relatively better predictors of the EHSCB criterion than they are with the grade point average criterion.

The relationships between the test predictors and the EHSCB criterion are seen to be higher than those for the total grade point average. This probably is due to the greater objectivity and reliability of a test score over a grade point average. It also is indicated that a test is more likely to correlate highly with another test by virtue of their common limitations of sampling performance than it is with teachers' ratings as reflected in school marks.

The mean composite score of the EHSCB criterion for boys and girls

was 125.46, respectively. The mean difference produced a t-ratio of 5.81, indicating a significant difference at below the one per cent level of confidence. Noting that the mean total grade point average for boys (2.24) was significantly lower than that for girls (2.37), a discrepancy is again apparent between the two criteria. This may be explained partially, however, by the fact that half of the EHSCB criterion consists of the science and mathematics sub-tests. Since boys tend to select these subject areas more than do girls, it is to be expected that they would achieve higher on this criterion.

II. THE MULTIPLE PREDICTION OF TOTAL GRADE POINT AVERAGE AND THE COMPOSITE SCORE OF THE EHSCB

In an attempt to determine the highest degree of prediction of total grade point averages with the test predictors used, the methods of multiple correlation and regression are utilized. The tables of inter-correlations for boys and girls, necessary for this type of analysis, are seen in Table 13. As mentioned in CHAPTER IV - METHODOLOGY, the procedure used for determining the standard partial regression coefficients was the abbreviated Doolittle method. The Doolittle solutions of the beta coefficients are recorded in Appendix A. Table 14 shows the solutions of the regression coefficients for boys and girls. The meaning of the symbols heading each column in Table 14 is as follows:

Column	Meaning
k	indicates each predictor variable.
B_{1k}	the beta weights for each k variable, 1 representing the dependent criterion variable
r_{1k}	the correlation coefficient between each predictor variable k and the criterion 1.

TABLE 13

INTER-CORRELATIONS AMONG THE PREDICTOR VARIABLES USED IN THE MULTIPLE REGRESSION ANALYSIS OF TOTAL GRADE POINT AVERAGES

Test Predictor Variables	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman-McNemar	English Prof.	Math. Prof.
			Girls				
Verbal Reasoning	.646	.541	.540	.651	.802	.713	.681
Numerical Ability		.541	.514	.595	.675	.622	.785
Mechanical Reasoning			.317	.482	.528	.466	.492
Spelling				.643	.625	.721	.567
Sentences					.673	.704	.632
Terman-McNemar						.838	.737
English Proficiency							.727
			Boys				
Verbal Reasoning	.523	.409	.579	.671	.767	.728	.534
Numerical Ability		.345	.451	.522	.549	.515	.741
Mechanical Reasoning			.163	.359	.401	.318	.386
Spelling				.614	.583	.685	.394
Sentences					.659	.687	.540
Terman-McNemar						.836	.575
English Proficiency							.564

TABLE 14

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF TOTAL GRADE POINT AVERAGES OF BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$		b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	.0138	.542	.0072	.0792	.0011	16.35	- .0180
Num. Ability	.1786	.613	.1095	.0902	.0161	16.00	- .2576
Mech. Reas.	-.0108	.310	-.0033	.0519	-.0006	35.38	.0212
Spelling	.0507	.438	.0222	.0286	.0015	25.44	- .0382
Sentences	.1247	.544	.0678	.0470	.0059	19.94	- .1176
Terman-McNemar	.2100	.582	.1222	.0447	.0094	109.98	-1.0338
English Prof.	-.0474	.539	-.0255	.0272	-.0013	100.95	.1313
Math. Prof.	.3401	.657	.2234	.0354	.0120	58.44	- .7013
			.5235=R^2			=	-2.0141
			.723=R			M1 =	2.2370
						a =	.2229
			Girls				
Verbal Reas.	-.0353	.596	-.0210	.0832	-.0029	15.96	.0463
Num. Ability	.2260	.686	.1550	.0942	.0213	14.59	- .3108
Mech. Reas.	.0076	.437	.0033	.0618	.0005	23.11	- .0116
Spelling	.1501	.582	.0882	.0263	.0039	33.53	- .1308
Sentences	.0474	.588	.0278	.0485	.0023	24.47	- .0563
Terman-McNemar	.2004	.661	.1325	.0439	.0088	107.72	- .9479
English Prof.	-.0122	.638	-.0078	.0273	-.0003	104.06	.0312
Math. Prof.	.2936	.716	.2102	.0363	.0107	54.42	- .5823
			.5883=R^2			=	-1.9622
			.767=R			M1=	2.3700
						a =	.4078

$B_{1k}r_{1k}$ the product of the same two columns.

$1/k$ the ratio of the standard deviation of the criterion to each of the predictor variable standard deviations.

b_{1k} the "b" coefficients of each variable (the product of the B_{1k} and $1/k$ columns).

M_k the means of each k predictor variable.

$(-M_k)b_{1k}$ the product of the (-) M_k and b_{1k} columns.

The multiple correlation coefficients are seen in the last row of each table. For boys and girls, these multiple correlation coefficients are seen to be .723 and .767, respectively. The standard errors of these correlations are .030 and .023 respectively. It is seen that the degree of prediction for girls is higher than for boys, although this difference did not prove to be statistically significant (z=.88). Both multiple correlations represent a rather high degree of prediction of the total grade point average. From Table 14, the final regression equations for predicting total grade point average may be written. For boys, the equation is as follows: total grade point average (X_{B1})=.0011X_2+.0161X_3 +.0006X_4+.0015X_5+.0023X_6+.0088X_7+.0003X_8+.0107X_9+.4078. (Standard error of multiple estimate $\pm$.414.) For girls, the equation is: total grade point average (X_{G1})=-.0029X_2+.0213X_3+.0005X_4+.0039X_5+.0023X_6+.0088X_7-.0003X_8 +.0107X_9+.4078. (Standard error of multiple estimate $\pm$.416). In the above equations, the meaning of the X subscripts refer to the test predictor variables in the same order as shown in Table 14.

With reference to Table 14, it will be noted that the Terman-McNemar Intelligence Test and the Mathematics Proficiency Test account for 34.56 per cent of the total 52.35 per cent of the variance accounted for through multiple regression. By using the equation for computing

multiple R with three variables, the following correlations with the criterion were obtained for boys and girls respectively; R=.703±.031, and .742±.025. It might be noted at this time that although the Numerical Ability Test for girls had a higher weighting in the total regression equation than did the Terman-McNemar Test, its correlation with the Mathematics Proficiency Test proved to be too high to make those two tests the best predictive combination.

By comparing the two multiple correlations for boys, it will be noted that the multiple R based on all eight variables (.723) accounts for only 2.85 per cent more variance than does the simple combination of the Terman-McNemar and Mathematics Proficiency Tests (.703). For girls, the difference between .767 and .742 indicates that the former coefficient accounts for only 3.70 per cent more variance than the latter. When tested for significance of difference, neither pair of multiple correlations proved to be statistically different.

It is obvious than, that it is more economical to use the regression equation based on the two predictor variables mentioned. By solving for the regression coefficients of these two variables in predicting total grade point average, the resulting regression equation was graphically represented by use of a nomograph. These nomographs for boys and girls are shown as Figures 1 and 2 in Appendix B. By connecting the two appropriate points found of the predictor test scales, the point at which the line crosses the middle axis indicates the best prediction of total grade point average.

For purposes of predicting the composite score of the EHSCB on the same nomograph scales as those used above, the regression equations

using the Terman-McNemar and Mathematics Proficiency Test toward predicting the EHSCB criterion were written and graphed accordingly.

The multiple correlations of these two test predictors with the EHSCB composite score were .858±.016 and .875±.013 for boys and girls, respectively. This degree of relationship is amazingly high, even though it is based on the correlation between test scores. In fact it represents a degree of relationship which often cannot be achieved in some test-retest reliabilities. The differences between these two correlations did not prove to be statistically significant.

CHAPTER VI

THE PREDICTION OF ACADEMIC SUCCESS IN EIGHT HIGH SCHOOL SUBJECT AREAS

The prediction of achievement in each of the subject areas represents, primarily, an attempt to provide educational information necessary to aid in the selection of high school majors which are appropriate to the abilities of the student. Information of this type also can be used to section students in various classes if this is consistent with the school's philosophy. In addition, it could be used to identify potential failures which may, for example, result in recommendations for attendance in special classes of a remedial nature. This would be particularly the case in areas such as English and mathematics. Subjects such as these, which frequently are required for graduation, must be pursued by a student even though he may not have the motivation and/or the ability necessary to succeed in them.

I. THE DIRECT PREDICTION OF SUBJECT AREA GRADE POINT AVERAGES AND THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY CRITERIA

Direct prediction of grade point averages in eight subject areas. It should be remembered that the grade point averages used as the criteria for success, represent average marks established in a subject area in which the student has taken three or more units of credit. Therefore, the ensuing correlations represent prediction over at least a three year period of time since all of the predictors were administered prior to the students' beginning his high school work.

Direct correlations of each test predictor variable with each high school subject area, within which students have selected majors, are seen in Table 15. Since all students are required to obtain three units of credit in English, all students in the study have majors in this area. The next most selected subject area from which majors were selected is social studies with 64.2% of the boys and 63.5% of the girls selecting this area for majors. There is little doubt that at least one reason for this rather high percentage is the fact that all students are required to obtain a minor, i.e. two units of credit, in social studies as a graduation requirement. Thus, with the addition of only one more subject in the area, the student can complete a major (three of which, including English, are required for graduation).

The next most selected subject area for girls is business education (56.8%), followed by science (41.5%), mathematics* (21.5%), foreign language (18.8%), and home economics (14.8%).

The next most selected subject area for boys is mathematics* (67.2%) followed by science (65.0%), industrial arts (27.8%), and foreign language (12.4%).

The most striking aspect of Table 15 is the consistently higher relationships between the test predictors and grade point averages among girls than among boys. This phenomenon was also noted in the prediction of total grade point averages. The only exception to this, noted in

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* These percentages are based on 71 girls and 179 boys who actually majored in mathematics in the three schools studied. Due to the necessity for ommitting the mathematics students from one school (because of its lack of uniformity with the other two schools) the figures in Table 15 indicate the numbers of mathematics majors in the two remaining schools.

TABLE 15

CORRELATIONS BETWEEN THE PREDICTOR VARIABLES AND GRADE POINT AVERAGES IN EACH OF THE SUBJECT-MATTER AREAS AND SEX

Subject Area	Sex	N	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math. Prof.
English	Boys	266	.496	.499	.125	.448	.455	.520	.514	.520
	Girls	329	.568	.661	.411	.570	.584	.687	.647	.690
Social Studies	Boys	171	.485	.495	.199	.361	.481	.553	.528	.538
	Girls	209	.554	.554	.389	.504	.551	.623	.595	.633
Science	Boys	173	.493	.527	.438	.308	.501	.541	.509	.627
	Girls	137	.570	.582	.422	.526	.524	.651	.590	.663
Mathe-matics	Boys	107	.379	.495	.271	.401	.428	.433	.408	.610
	Girls	51	.566	.654	.506	.624	.566	.622	.617	.671
Foreign Language	Boys	33	.051*	.485	.219*	.032*	.019*	-.023*	-.046	.411
	Girls	62	.421	.633	.219	.637	.498	.529	.517	.628
Indus. Arts	Boys	74	.268	.222*	.194*	.322	.307	.307	.290	.364
Home Econ.	Girls	49	.359	.486	.167*	.215*	.415	.511	.589	.409
Bus. Ed.	Girls	187	.390	.525	.330	.403	.371	.466	.456	.571

* Not significantly different from zero at the five per cent level of confidence.

those subject areas in which both boys and girls have majored, is in the case of the Mechanical Reasoning Test as it relates to science grades. In this case only is the degree of relation higher for boys than for girls. The difference, however, is not statistically significant as seen in Table 16. In the latter table, the correlations found in Table 15 were tested for significance of difference for each test predictor and subject area in which comparisons could be made between boys and girls.

Table 16 indicates that the test predictors in general, show the greatest amount of differential prediction, due to sex, in the subject areas of English and foreign language. In the case of English, only two of the eight test predictors (Verbal Reasoning and Spelling) failed to show a significant difference between the sexes.

In the area of foreign language, the Spelling, Sentences, Terman-McNemar, and English Proficiency Tests showed significant differential prediction. It is interesting to note that these predictors are all measures of verbal or linguistic facilities. By referring back to Table 15, it will be seen that these same tests failed to prove significantly different from zero correlation with the foreign language achievement boys. For girls, the case is quite the contrary. In fact, all of the predictor tests show a substantial correlation with foreign language achievement among girls with the exception, perhaps, of the Mechanical Reasoning Test.

In only two other cases, namely, the Mechanical Reasoning Test in social studies and the Spelling Test in the science area, did the differences in the correlations between boys and girls prove to be

TABLE 16

z-RATIOS INDICATING THE SIGNIFICANCE OF DIFFERENCE BETWEEN CORRELATIONS FOR BOYS AND GIRLS IN EACH SUBJECT AREA IN WHICH BOTH SEXES HAVE MAJORED

Subject Area	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math. Prof.
English	1.25	3.68**	3.59**	1.95	2.15*	3.13**	2.35*	3.24**
Social Studies	.92	.80	2.80**	1.72	.91	1.03	.92	1.40
Science	.95	.68	.21	2.27*	.21	1.48	1.00	.60
Mathematics	1.38	1.38	1.60	1.77	1.03	1.48	1.61	.38
Foreign Language	1.78	.98	.00	3.21**	2.37*	2.80**	2.75**	.14

* Indicates significance of difference at the five per cent level of confidence.
** Indicates significance of difference at the one per cent level of confidence.

statistically significant.

Referring to Table 16 as a whole, twelve out of the forty comparisons proved to be statistically significantly different. It is not to be denied, however, that although these differences did not prove to be significant in many cases, there is obviously a tendency for girls to be a more predictable group with the type of tests and criteria used in this study. In this, sheer numbers and cumulative probabilities reflect a genuine difference in predictability rather than single tests of statistical significance taken alone.

A combination of two factors may help to explain the phenomenon. The first involves the greater restriction of range (seen in Table 11 of CHAPTER V) among boys than among girls. A plausible explanation for the greater restriction of range was put forth in that chapter where it was stated that a higher percentage of boys than girls drop out of school; these drop-outs representing, on the whole, students of lower academic ability. Thus, the boys remaining in the twelfth grade represent a more homogeneous and able group than do the girls as a group. The greater restriction of range would,of course, discourage high correlation.

A second factor possibly operating to cause this phenomenon is the probable greater degree of objectivity excercised in marking girls. Due to their greater conformance and compliance, it would be expected that fewer extraneous variables would be allowed to influence the marks given. Boys, on the other hand, would more likely be graded down, not necessarily because of poorer achievement but because of factors such as poor attitude, aggressiveness, non-conformance in the school situation, etc. If this were the case, it would lend toward lower measures of

relationship between grades and the test predictors.

To summarize the best predictors of each subject area, Table 17 is presented. An examination of this table will reveal that in nine out of thirteen cases, the Mathematics Proficiency Test is the best single predictor of grade point averages. This instrument is one of the best three predictors in every instance except in the case of predicting home economics grade point averages. The Terman-McNemar, Numerical Ability, Spelling and English Proficiency Tests proved to be the best single predictors in the subject areas of social studies (girls), foreign language (boys and girls), and home economics (girls), respectively.

It seems peculiar that a Mathematics achievement test should be among the best predictors in areas such as English, social studies, and foreign language, since in terms of course content at least, this type of ability would be seemingly unnecessary. Of the forty best predictors shown in Table 17, the Mathematics Proficiency Test appears twelve times; the Terman-McNemar, ten times; the Numerical Ability, seven times; the English Proficiency Test, six times; the Spelling Test, three times; and the Sentences and Mechanical Reasoning Tests, one time each.

The subject areas open to the highest prediction are English, social studies, science and mathematics, or what are commonly called the tool subjects. Every correlation presented in these subject areas is significantly different from zero. This is in part due to the larger numbers of students selecting these areas for majors. Of the forty coefficients presented for the remaining subject areas, i.e. industrial arts, foreign language, home economics and business education, ten are

TABLE 17

A SUMMARY OF THE THREE BEST PREDICTORS OF GRADE POINT AVERAGES IN EACH SUBJECT AREA AND EACH SEX

Subject Area	Sex	Best Three Predictors 1st		2nd		3rd	
English	Boys	Math. Prof.	(.520)	Terman I.Q.	(.520)	English Prof.	(.514)
	Girls	Math. Prof.	(.690)	Terman I.Q.	(.687)	English Prof.	(.647)
Social Studies	Boys	Terman I.Q.	(.553)	Math. Prof.	(.538)	English Prof.	(.528)
	Girls	Math. Prof.	(.663)	Terman I.Q.	(.623)	English Prof.	(.595)
Science	Boys	Math. Prof.	(.627)	Terman I.Q.	(.541)	Num. Ability	(.527)
	Girls	Math. Prof.	(.663)	Terman I.Q.	(.651)	English Prof.	(.590)
Mathematics	Boys	Math. Prof.	(.610)	Num. Ability	(.495)	Terman I.Q.	(.433)
	Girls	Math. Prof.	(.671)	Num. Ability	(.654)	Spelling	(.624)
Foreign Language	Boys	Num. Ability	(.485)	Math. Prof.	(.411)	Mech. Reas.	(.219)
	Girls	Spelling	(.627)	Num. Ability	(.633)	Math. Prof.	(.628)
Industrial Arts	Boys	Math. Prof.	(.364)	Spelling	(.322)	Sentences and Terman I.Q.	(.307)
Home Economics	Girls	English Prof.	(.589)	Terman I.Q.	(.511)	Num. Ability	(.486)
Business Education	Girls	Math. Prof.	(.571)	Num. Ability	(.525)	Terman I.Q.	(.466)

not significantly different from zero. Six of these ten occurring in the prediction of foreign language achievement of boys.

The greatest discrepancy in the prediction of subject areas between boys and girls lies in the foreign language area. The correlations shown in this area for boys are, on a whole, negligible, while for girls, the coefficients are very much greater. The two best predictors of foreign language success for boys and girls, however, (the Mathematics Proficiency and the Numerical Ability Tests) are the same for both sexes.

For purposes of comparing the results of other investigations as reported in the validity section of the DAT manual, Table 18 is presented. The average correlations shown have no intrinsic use and in some cases may be misleading in terms of judging the battery. Since these averages are based on those sub-tests which are poor predictors as well as good predictors, it is not expected that the average correlations for each subject area would be high. On the contrary, the basic premise upon which this battery was built was the idea that different courses and subject areas would require different abilities for success. Table 18 is shown for comparative purposes. The procedure used in averaging the correlation coefficients is described in CHAPTER IV.

Table 18 reveals that on a whole, the average correlations of the Differential Aptitude Tests used in this study, using grade point average criteria, are higher than those derived from the manual. The coefficients reported in the manual also reflect slightly higher correlations for girls than for boys but apparently not as different as those found in this study. It is also seen that the correlations reported in the DAT manual tend to be higher in predicting achievement in the tool subjects

TABLE 18

A COMPARISON OF THE AVERAGE DAT* VALIDITY COEFFICIENTS ESTABLISHED IN THIS STUDY AND THOSE DERIVED FROM THE DATA PRESENTED IN THE DAT MANUAL, BY SEX, AND SUBJECT AREA, FOR THE DAT PREDICTORS USED

Subject Area	Sex	Average r found in this study	Average r computed from data in DAT manual**
English	Boys	.410	.430
	Girls	.565	.450
Social Studies	Boys	.405	.390
	Girls	.510	.430
Science	Boys	.460	.455
	Girls	.525	.465
Mathematics	Boys	.400	.320
	Girls	.585	.390
Foreign Language	Boys	.170	.350
	Girls	.495	.290
Industrial Arts	Boys	.260	.215
Home Economics	Girls	.335	.395
Business Education	Girls	.425	.310

* These averages are based on the Verbal Reasoning, Numerical Ability, Mechanical Reasoning, Spelling and Sentences subtests.

** These average r's are based on either the median r's found in the DAT manual for each DAT subtest used or on personally computed medians in areas in which medians were not reported.

than in the remaining areas. This is consistent with the findings of this study.

Direct prediction of the Essential High School Content Battery criteria. As was the case in the prediction of general academic success, the Essential High School Content Battery (EHSCB) will now be used as an alternate criterion of success. As mentioned in an earlier chapter, this battery was administered to the current senior class during the month of May in their junior year. Since the predictors were administered at the end of their eighth grade, prediction is thus established over a three year period of time for this criterion.

Because the EHSCB measures achievement in only four subject areas, i.e. English, mathematics, social studies, and science, it could be used for comparative purposes and as an alternate criterion in these four areas only. The direct zero order correlations of the test predictors with each of the EHSCB tests are shown in Table 19.

In general, the relationships shown in Table 19 are impressively high especially when compared to the results of similar reported investigations. As was the case in the prediction of grade point averages, the prediction of girls achievement is consistently higher than for boys. Another notable aspect of this table is the consistently higher prediction of achievement using the EHSCB criteria than was found when grade point averages were used as the criteria of success. It is to be expected, however, that test scores are more likely to correlate higher with other test scores than they are with teachers' ratings of student performance as reflected by grades. The increased prediction of the EHSCB criteria over the grade point average criteria in the same subject

TABLE 19

CORRELATIONS BETWEEN THE PREDICTOR VARIABLES AND THE FOUR SUBTESTS OF THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY FOR BOYS AND GIRLS

EHSCB Subtest	Sex	N	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math. Prof.
English	Boys	266	.699	.591	.330	.653	.680	.767	.766	.629
	Girls	329	.680	.676	.466	.719	.688	.818	.810	.717
Social Studies	Boys	171	.573	.484	.177	.424	.489	.674	.612	.498
	Girls	209	.640	.567	.436	.552	.574	.745	.686	.634
Science	Boys	173	.647	.486	.491	.462	.571	.730	.653	.541
	Girls	137	.697	.630	.571	.563	.624	.793	.694	.672
Mathematics	Boys	107	.480	.619	.408	.384	.498	.557	.468	.673
	Girls	51	.650	.680	.509	.543	.566	.687	.616	.690

areas is shown in Table 20.

For purposes of comparison, the eight correlations between the predictors and the appropriate criteria, by subject area and sex, have been averaged.

TABLE 20

A COMPARISON OF THE AVERAGE CORRELATIONS BETWEEN THE PREDICTORS AND THE EHSCB TESTS AND GRADE POINT AVERAGES BY SEX AND SUBJECT AREA

		Criteria	
Subject Area	Sex	Grade Point Average	EHSCB Tests
English	Boys	.455	.655
	Girls	.610	.710
Social Studies	Boys	.450	.505
	Girls	.555	.610
Science	Boys	.500	.580
	Girls	.570	.660
Mathematics	Boys	.435	.520
	Girls	.605	.625

Table 20 reveals that in every instance, for both boys and girls, the average correlations between the test predictors and the EHSCB criteria are higher than between the test predictors and the grade point average criteria. A comparison of the average correlation coefficients between boys and girls on the EHSCB criteria confirms the tendency shown in a similar comparison with grade point average criteria, i.e. the predictive relationships among girls is higher than among boys. This fact would lend support to the idea that girls are to some extent at least, more consistent in their performance on different tests and in terms of

their test-grade point average relationship, than are boys. Thus, the idea that boys may be graded more inconsistently than girls does not answer the whole question since even on an objective achievement test, the relationships among girls are higher than for boys. This is certainly a fact which should be considered in future prediction studies.

Although the correlations with the EHSCB criteria are higher, it is interesting to notice that a ranking of the subject areas in order of their predictability is similar with both criteria. Thus, English is, in general, the area open to the highest prediction, followed by science, mathematics, and social studies.

Table 21 summarizes the best three predictors in each subject area of the EHSCB. This table shows the Terman-McNemar Intelligence Test to be one of the best predictors in each of the subject areas for both boys and girls. The English Proficiency Test seems to be the second best all-around predictor, appearing six times in Table 21, followed by the Verbal Reasoning Test appearing five times, the Mathematics Proficiency Test and the Numerical Ability Tests each appearing two times and the Spelling Test appearing one time.

In comparing Table 21 with Table 17, one finds a striking difference in the type of predictors which are most effective. For example, in comparing these four subject areas only, if the predictors were dichotomized into a "number" or quantitative group and another group measuring "verbal" or linguistic abilities, it would be found that for the prediction of grade point averages the "number" tests, i.e. the Mathematics Proficiency Test and the Numerical Ability Test, appear in nine out of twenty-four cases. In the prediction of the EHSCB test

TABLE 21

A SUMMARY OF THE THREE BEST PREDICTORS OF THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY FOR BOYS AND GIRLS

Subject Area	Sex	Best Three Predictors 1st	2nd	3rd
English	Boys	Terman I.Q. (.767)	English Prof. (.766)	Verbal Reas. (.699)
	Girls	Terman I.Q. (.818)	English Prof. (.810)	Spelling (.719)
Social Studies	Boys	Terman I.Q. (.674)	English Prof. (.612)	Verbal Reas. (.573)
	Girls	Terman I.Q. (.745)	English Prof. (.686)	Verbal Reas. (.640)
Science	Boys	Terman I.Q. (.730)	English Prof. (.653)	Verbal Reas. (.647)
	Girls	Terman I.Q. (.793)	Verbal Reas. (.697)	English Prof. (.694)
Mathematics	Boys	Math. Prof. (.673)	Num. Ability (.619)	Terman I.Q. (.557)
	Girls	Math. Prof. (.690)	Terman I.Q. (.687)	Num. Ability (.680)

scores, the "number" tests appear in only four of the twenty-four cases; the remaining predictor tests being in the "verbal" group. In general the Verbal Reasoning and the English Proficiency Tests, especially the former, have taken the place of the Mathematics Proficiency and the Numerical Ability Tests as the best three predictors.

Verbal (primarily reading) skills are to a large extent, the factors being measured by the typical paper and pencil achievement test regardless of whether the test content is English, social studies, science etc. By its very nature, however, the Mathematics Proficiency test requires much less verbal ability for achievement.

A fundamental difference between the two criteria used has been brought to light. On the one hand, the EHSCB criterion, measuring verbal skills and abilities to a large extent, finds as its best predictors those instruments measuring these very abilities. On the other hand, grade point averages, apparently based to a larger extent upon quantitative abilities, finds as its best predictors, those tests measuring number abilities. The Terman-McNemar Test stands as one of the best predictors for both of the criteria. Since verbal abilities are inherent in both criteria, and since the Terman-McNemar Test is a verbal intelligence test, it probably reflects a general intelligence factor permeating all achievement.

The variance common to both criteria is shown in the correlations presented in Table 22.

The coefficients shown in Table 22 express moderately high relationships between the EHSCB criteria and the grade point average criteria. The fact that the correlations are higher for girls than for

boys supports a previous statement that girls are graded more consistently with their achievement than are boys, however, the data are somewhat conflicting.

TABLE 22

CORRELATIONS BETWEEN THE EHSCB CRITERIA AND GRADE POINT AVERAGES IN CORRESPONDING SUBJECT AREAS, BY SEX

Variable	Boys		Girls	
	N	r	N	r
EHSCB English Test vs. English Grade Point Averages	266	.613	329	.734
EHSCB Social Studies Test vs. Social Studies Grade Point Averages	171	.677	209	.722
EHSCB Science Test vs. Science Grade Point Averages	173	.589	137	.678
EHSCB Mathematics Test vs. Mathematics Grade Point Averages	107	.736	51	.749

It is seen that the highest relationship between the two criteria lies in the subject area of mathematics. This is probably because of this area being more factorially pure than the other subject areas.

The lowest relationship between the criteria is in the social studies area. Considering the differences between the two criteria, however, all the relationships shown in Table 22 are rather high ranging from .589 to .749.

In order to secure higher predictions, the methods of multiple correlation and regression will now be applied to the prediction of the criteria.

II. MULTIPLE PREDICTION OF GRADE POINT AVERAGES AND THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY CRITERIA

Multiple prediction of grade point averages in eight high school subject areas. In an attempt to achieve the highest degree of prediction of grade point averages in each subject area investigated, and through the use of the independent variables used in this study, the methods of multiple correlation and regression are employed. In order to achieve this purpose, essentially four steps are involved. The first step is to secure the inter-correlations among the predictor tests used and the criteria. The inter-correlations among the predictor tests were those computed from an analysis of the total group of boys (266) and the total group of girls (329). The rationale for using the same inter-correlations for each of the sub-groups studied is stated in CHAPTER IV.

The second step is the solution of the normal equations leading to the appropriate weightings for each of the independent variables. These weightings (beta coefficients) were solved by using the abbreviated Doolittle method referred to in CHAPTER IV. These solutions, by subject area and sex, are found in Appendix A.

The third step involves the solutions of the regression coefficients. From this step, the beta coefficients which are the weightings of the independent variables in standard score form are converted to "b" coefficients which are final weightings in raw score form. This step also includes the solution of the constant "a", and also the computation of the multiple correlation coefficient.

The fourth step is the writing of the multiple regression equation based on the solution of the regression coefficients.

These steps will now be related in successive order. For reference to steps one and two, the reader's attention may be called to Table 13, CHAPTER 5 and to Appendix A, respectively.

The solutions to the regression coefficients, by subject area and sex, are found in Tables 43 through 50 of Appendix B. The multiple correlation coefficient appears at the bottom of the third column in the latter tables. The meaning of the column headings are similar to those described in CHAPTER V.

Through a cursory inspection of Tables 43 through 50, one is immediately impressed with the appearance of numerous negative beta coefficients. Under certain circumstances, negative beta weightings may be interpreted as the variables acting as suppressor tests. This situation arises when the variable given the negative beta weight has a low (and often positive) correlation with the criterion and a high correlation with the test for which it is acting as a suppressor.[1] In the previous analyses, all the predictor variables correlate to a moderate extent with the criteria except in the instance of foreign language achievement of boys. In this case, the three predictors given negative beta weights are Sentences, Terman-McNemar, and the English Proficiency Test. The tests showing the highest correlation with the criterion are the Mathematics Proficiency and the Numerical Ability Tests. Since none of the negatively weighted predictors show a high relation with the mathematics tests, it is unlikely they are correlating to any great degree with non-valid variance in the mathematics tests.

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[1] Thorndike, op. cit., p. 192.

Since each of the predictor variables studied is a paper and pencil achievement test (in the broad sense of the term), it is likely that most of the negative beta coefficients can be explained by sampling fluctuations of the correlation coefficients. Due to the great changes in the values of the beta coefficients through sampling fluctuations of the correlations, it is difficult to interpret the negative beta coefficients as being significantly indicative of suppression.[2] This is a problem which requires further analysis but is beyond the scope of this investigation.

A summary of the multiple correlations derived from Tables 43 through 50 is contained in Table 23 along with their computed standard errors of multiple correlation. All of these correlations proved to be significantly different from zero at the one percent level of confidence. It will be noticed that the subject area from which the highest multiple correlation for boys and girls was derived is foreign language. This is interesting particulary since foreign language majors were found to be one of the most selected and restricted subject area groups. It should be pointed out that the size of the beta coefficients is not only a function of the correlation with the criterion, but also a function of the variable's inter-correlation with other variables. In the case of foreign language achievement, although the individual predictor correlations with the criterion were not relatively high, apparently the particular combination of the predictors given the most weighting had relatively

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[2]Edward E. Cureton, "II. Approximate Linear Restraints and Best Predictor Weights," Symposium: The Need and Means of Cross Validation, Educational and Psychological Measurement, 13:13, Spring, 1951.

TABLE 23

A SUMMARY OF THE MULTIPLE CORRELATION COEFFICIENTS WITH THE STANDARD ERRORS, USING EIGHT TEST VARIABLES AS PREDICTORS OF GRADE POINT AVERAGES IN EACH SUBJECT AREA AND SEX

Subject Area	N	Sex	Multiple Correlation Coefficients R	S.E.
English	266	Boys	.635	.037
	329	Girls	.765	.023
Social Studies	171	Boys	.640	.046
	209	Girls	.692	.037
Science	173	Boys	.692	.041
	137	Girls	.715	.043
Mathematics	107	Boys	.642	.059
	51	Girls	.766	.063
Foreign Language	33	Boys	.666	.121
	62	Girls	.774	.055
Industrial Arts	74	Boys	.448	.098
Home Economics	49	Girls	.660	.088
Business Education	187	Girls	.644	.044

low inter-correlations with the other predictors. Thus, the final multiple correlation is larger than one would expect. Apparently the two tests given the most weighting in the prediction of foreign language grade point averages for boys are the Numerical Ability Test and the Mathematics Proficiency Test. For girls, the two tests given the most weighting are the Spelling and Numerical Ability Tests. The Mathematics Proficiency Test also is rather highly weighted in the latter prediction.

It is apparent that in the case of girls, the Spelling Test shows a considerable correlation with the criterion (.637), while for boys the correlation (.032) is not significantly different from zero. Why the Spelling Test should be a good predictor of language grade point average for girls and not for boys is not completely understood. Probably part of the explanation lies in the difference between the variabilities on the Spelling Test for boys and girls. For boys, the standard deviation is 21.80, while for girls it is 27.60. Obviously, the greater restriction of range exhibited by the boys is one determining factor of the phenomenon; however, whether it is the sole cause of the discrepancy is not known.

The next area open to the highest prediction for boys and girls is mathematics, followed by English, science, social studies, home economics, business education and industrial arts. The range of correlations seen in Table 23 is from .448 to .766. It might be said that, in general, the coefficients are larger than those generally found in the literature concerning studies of this type.

The fourth step in this multiple regression problem involves the writing of total regression equations based on the eight predictors.

These equations, for each subject area and sex, are found in Appendix D.

One of the objectives of this study was to determine whether the two predictor combinations producing the highest multiple correlation in each subject area and for each sex, differed significantly from a similar analysis of the multiple correlations derived from a combination of all eight predictors. To this end, Table 24 presents the names and the best two predictor combinations, separated by subject area and sex. The maximum (eight variable) correlations in each subject area and sex also are presented, together with the final test of significance of difference between the two multiple correlations. It is seen that in no case is the difference between the two multiple correlations statistically significant.

The range of multiple correlations derived from the various two-predictor combinations is form .413 to .740, with a median of .642. The range derived from a combination of all eight predictor tests is from .448 to .766, with a median of .666.

Table 24 also shows the Terman-McNemar and Mathematics Proficiency Tests combination to provide the highest multiple correlations in six out of the thirteen cases.

In every case, either the Mathematics Proficiency, Numerical Ability Tests, or both, entered into the highest two-predictor combinations. In four out of the thirteen cases, a combination of the Spelling Test and one of the "number" tests proved to be the best dual combination. One of the reasons for this is the relatively low correlation between the spelling and number tests as seen in Table 13.

Since it is an objective of this study to interpret the findings in such a way as to make them usable and understandable to counselors,

TABLE 24

THE MULTIPLE CORRELATIONS AND STANDARD ERRORS OF THE BEST TWO PREDICTOR COMBINATIONS, THE TOTAL PREDICTOR COMBINATION, AND THE SIGNIFICANCE OF DIFFERENCE BETWEEN THESE TWO MULTIPLE CORRELATIONS FOR EACH SUBJECT AREA AND SEX

Subject Area	Sex	N	Best Two Predictor Combination	Two Variable R	Two Variable S.E.	Eight Variable R	Eight Variable S.E.	z-ratio
English	Boys	266	Math. Prof. and Terman I.Q.	.587	.041	.635	.037	.917
	Girls	329	Math. Prof. and Terman I.Q.	.740	.025	.765	.023	.741
Social Studies	Boys	171	Math. Prof. and Terman I.Q.	.615	.049	.640	.046	.374
	Girls	209	Math. Prof. and Terman I.Q.	.679	.038	.692	.031	.193
Science	Boys	173	Math. Prof. and Terman I.Q.	.665	.043	.692	.041	.423
	Girls	137	Math. Prof. and Terman I.Q.	.705	.043	.715	.043	.163
Mathe-matics	Boys	107	Math. Prof. and Spelling	.642	.057	.642	.056	.000
	Girls	51	Math. Prof. and Spelling	.733	.066	.766	.063	.333
Foreign Language	Boys	33	Num. Ability and Mech. Reas.	.529	.129	.666	.121	.823
	Girls	62	Num. Ability and Mech. Reas.	.730	.060	.774	.055	.564
Industrial Arts	Boys	74	Math. Prof. and Spelling	.413	.098	.448	.098	.256
Home Economics	Girls	49	Terman I.Q. and Num. Ability	.545	.102	.660	.088	.873
Business Education	Girls	187	Math. Prof. and Num. Ability	.584	.048	.644	.044	.931

the regression equations based on each of the two-predictor combinations of Table 24 were graphically represented in nomograph form. These nomographs, by sex and subject area, are seen as Figures 3 through 15 in Appendix C.

Multiple prediction of the Essential High School Content Battery criteria. Since the EHSCB criteria play a secondary role to the grade point average criteria, and since it was found that in the latter predictions there were no significant differences in the multiple correlations derived through the use of two and eight variable combinations, the multiple prediction of the EHSCB tests was accomplished by selecting the two predictor tests producing the highest multiple correlation. These tests with the multiple correlations and respective standard errors for each EHSCB test is shown in Table 25.

Table 25 shows correlations ranging from .687 to .860. The subject area open to the highest prediction is seen to be English, followed by science, mathematics, and social studies.

In five out of the eight cases, the Terman-McNemar and the Mathematics Proficiency Test combination showed the highest two-predictor multiple correlation. In the case of boys, this is explained by the relatively low inter-correlation of these tests (.575). The Terman-McNemar Test appears in seven out of the eight cases and shows, on the whole, to be the best single predictor of the EHSCB tests.

III. THE SIGNIFICANCE OF DIFFERENCE BETWEEN SUBJECT AREA MAJORS

On preceding pages, the ability of the predictor tests to correlate with the various criteria has been evaluated. In this section, an

TABLE 25

MULTIPLE CORRELATIONS AND STANDARD ERRORS OF THE TWO-PREDICTOR COMBINATIONS IN PREDICTING SCORES ON THE ESSENTIAL HIGH SCHOOL CONTENT BATTERY FOR BOYS AND GIRLS

EHSCB Subtest	Sex	N	Best Two-Predictor Combinations: Tests	R	S.E.
English	Boys	266	English Proficiency and Math. Proficiency	.802	.022
	Girls	329	Spelling and Terman I.Q.	.860	.014
Social Studies	Boys	171	Terman I.Q. and Math. Proficiency	.687	.041
	Girls	209	Terman I.Q. and Math. Proficiency	.756	.030
Science	Boys	173	Terman I.Q. and Math. Proficiency	.745	.034
	Girls	137	Terman I.Q. and Math. Proficiency	.804	.030
Mathematics	Boys	107	Terman I.Q. and Math. Proficiency	.704	.049
	Girls	51	Terman I.Q. and Numerical Ability	.760	.051

attempt will be made to evaluate the magnitude of the differences in performance on each of the predictor tests, comparing the means of the students majoring in a given subject area with those not majoring in that area. These evaluations will be made for boys and girls separately.

Table 26 presents the mean scores on the predictor tests made by boys majoring in a given subject area and those not majoring in that subject area. The significance of differences between each pair of means is indicated by the "t" ratios.

An examination of Table 26 shows that only two out of the forty t-ratios presented failed to reject the null hypothesis. The two exceptions are in comparing the Mechanical Reasoning means of foreign language majors and non-majors and in comparing the Spelling Test means of the mathematics majors and non-majors.

It is also evident from Table 26 that, in general, the group of boys majoring in foreign language represents the most able group of students. Their relatively higher performance on the two achievement test predictors, the Mathematics Proficiency and English Proficiency Tests, is worthy of note.

The science majors seem to represent the second most capable group although this group is not greatly different from the mathematics majors in terms of their mean test performance. The social studies and industrial arts majors, on a whole, rank fourth and fifth, respectively, in their mean test performance.

It must be remembered that the rankings above are on a group basis and are valid and meaningful in this context only. The reason for this is that each student has majored in at least three subject areas;

TABLE 26

THE MEAN SCORES AND "t" RATIOS ON THE PREDICTOR TESTS MADE BY BOYS MAJORS AND NON-MAJORS IN EACH OF FIVE SUBJECT AREAS

Predictor Test		Social Studies		Science		Mathematics	
		Major	Non-Major	Major	Non-Major	Major	Non-Major
Verb. Reas.	N	171	95	173	93	107	87
	M	15.43	18.01	17.36	14.47	17.08	14.35
	t	2.74		2.97		2.60	
Num. Abil.	N	171	95	173	93	107	87
	M	14.81	18.14	16.98	14.18	17.50	12.79
	t	3.83		3.21		4.98	
Mech. Reas.	N	171	95	173	93	107	87
	M	33.41	38.93	36.69	32.96	38.67	31.74
	t	3.29		2.48		4.20	
Spell.	N	171	95	173	93	107	87
	M	26.13	24.20	27.39	21.81	23.17	23.46
	t	.69*		2.17		.09*	
Sent.	N	171	95	173	93	107	87
	M	18.17	23.13	22.02	16.07	22.38	17.06
	t	2.98		3.62		3.02	
Terman I.Q.	N	171	95	173	93	107	87
	M	107.85	113.81	111.90	106.41	112.20	106.07
	t	3.50		3.08		3.22	
Eng. Prof.	N	171	95	173	93	107	87
	M	97.40	107.34	103.92	95.43	104.55	96.86
	t	3.62		2.86		2.46	
Math. Prof.	N	171	95	173	93	107	87
	M	55.29	64.11	60.07	55.41	61.28	50.35
	t	3.92		2.17		4.25	

* Lacks significance of difference at the five per cent level of confidence.

TABLE 26 (continued)

Predictor Test		Foreign Language Major	Foreign Language Non-Major	Industrial Arts Major	Industrial Arts Non-Major
Verb. Reas.	N	33	233	74	192
	M	21.85	15.57	12.51	17.83
	t	4.36		5.91	
Num. Abil.	N	33	233	74	192
	M	19.61	15.49	13.64	16.91
	t	3.40		3.89	
Mech. Reas.	N	33	233	74	192
	M	37.15	35.13	32.48	36.50
	t	.96*		2.56	
Spell.	N	33	233	74	192
	M	43.15	22.93	17.68	28.43
	t	4.10		6.95	
Sent.	N	33	233	74	192
	M	28.06	18.79	12.31	22.88
	t	4.10		6.95	
Terman I.Q.	N	33	233	74	192
	M	119.69	108.60	103.09	112.64
	t	5.23		5.71	
Eng. Prof.	N	33	233	74	192
	M	120.48	98.18	88.04	105.93
	t	7.79		6.19	
Math. Prof.	N	33	233	74	192
	M	70.18	56.76	52.08	60.89
	t	6.11		3.88	

* Lacks significance of difference at the five per cent level of confidence.

thus, a student majoring in a foreign language may also have elected to major in inudstrial arts and science. In general, however, students elect certain sequences of subject areas for majors, e.g. college bound students generally elect a foreign language, mathematics and/or science as high school majors.

An analysis similar to the one for boys is shown in Table 27 for girls. The analysis and interpretaion of Table 27 is seen to be much the same as it was for boys; the outstanding features being:

1. Only one pair of means lack statistical significance of difference; this involving the Spelling Test in the subject area of mathematics.

2. In general, the differences between the means shown for girls is of a greater magnitude than the differences shown for boys in Table 26.

3. A relative ranking of the subject area majors from high to low shows that, in general, foreign language majors tend to be the most able group followed by the mathematics, science, social studies, business education and home economics majors.

4. By reference to the mean Terman-McNemar I.Q.'s for each group, it will be noted that there is a distinct break between the foreign language, mathematics, and science majors whose mean I.Q.'s are 119.68, 118.41, and 112.09, respectively, and the mean I.Q.'s of the social studies, business education, and home economics majors, whose mean I.Q.'s are 105.09, 102.82, and 97.30, respectively. These facts probably can be explained in terms of the similar sequence of majors established by students. For example, pupils majoring in foreign language also

TABLE 27

THE MEAN SCORES AND "t" RATIOS ON THE PREDICTOR TESTS MADE BY GIRL MAJORS AND NON-MAJORS IN EACH OF SIX SUBJECT AREAS

Predictor Test		Social Studies Major	Social Studies Non-Major	Science Major	Science Non-Major	Mathematics Major	Mathematics Non-Major
Verb. Reas.	N	209	120	137	192	71	258
	M	14.70	18.15	18.12	14.42	21.55	14.42
		3.60		4.08		6.15	
Num. Abil.	N	209	120	137	192	71	258
	M	13.28	16.87	16.09	13.52	20.21	13.04
	t	4.30		3.23		8.06	
Mech. Reas.	N	209	120	137	192	71	258
	M	21.69	25.58	24.91	21.83	29.42	21.37
	t	3.81		2.58		6.44	
Spell.	N	209	120	137	192	71	258
	M	30.05	39.59	35.91	31.83	44.90	30.23
	t	3.26		1.46*		4.25	
Sent.	N	209	120	137	192	71	258
	M	21.69	28.76	26.80	22.46	31.96	22.15
	t	4.53		2.87		5.67	
Terman I.Q.	N	209	120	137	192	71	258
	M	105.09	112.30	112.09	104.60	118.41	104.78
	t	4.19		4.54		8.07	
Eng. Prof.	N	209	120	137	192	71	258
	M	99.95	113.72	108.98	100.55	118.11	100.19
	t	5.00		3.19		6.68	
Math. Prof.	N	209	120	137	192	71	258
	M	50.71	60.88	58.34	51.62	68.66	50.50
	t	4.87		3.34		8.99	

* Lacks significance of difference at the five per cent level of confidence.

TABLE 27 (continued)

Predictor Test		Home Economics Major	Home Economics Non-Major	Foreign Language Major	Foreign Language Non-Major	Business Education Major	Business Education Non-Major
Verb. Reas.	N	49	280	62	267	187	142
	M	11.12	16.81	22.51	14.43	13.59	19.08
	t	6.62		6.62		5.90	
Num. Abil.	N	49	280	62	267	187	142
	M	10.41	15.32	20.48	13.22	12.97	16.72
	t	5.45		7.72		5.69	
Mech. Reas.	N	49	280	62	267	187	142
	M	17.29	24.13	29.05	21.73	20.24	26.89
	t	4.75		5.23		5.59	
Spell.	N	49	280	62	267	187	142
	M	20.71	35.77	49.06	29.92	29.08	39.39
	t	5.12		5.04		3.66	
Sent.	N	49	280	62	267	187	142
	M	18.65	25.25	34.06	22.00	20.71	28.96
	t	3.57		6.48		5.39	
Terman I.Q.	N	49	280	62	267	187	142
	M	97.30	109.54	119.68	104.94	102.82	114.17
	t	6.69		7.37		6.72	
Eng. Prof.	N	49	280	62	267	187	142
	M	89.20	106.66	119.16	100.56	97.98	112.07
	t	5.10		6.01		5.34	
Math. Prof.	N	49	280	62	267	187	142
	M	43.63	56.31	67.84	51.30	49.92	60.35
	t	4.45		7.62		5.11	

frequently major in science and/or mathematics.

In the next chapter, the summary, conclusions and implications for further research will be presented.

CHAPTER VII

SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER RESEARCH

I. SUMMARY

This study was designed to inquire into the single and combined value of seven measures of aptitude and achievement to predict academic success in each of eight subject areas at the high school level, i.e. English, social studies, science, mathematics, industrial arts, foreign language, home economics, and business education, in addition to predicting the general academic success of high school students.

The predictive measures used consisted of two achievement tests, the Mathematics Proficiency, and English Proficiency tests; four special aptitude tests of the Differential Aptitude Battery, i.e. Verbal Reasoning, Numerical Ability, Mechanical Reasoning, and Language Usage (consisting of Spelling and Sentences sub-tests); and a measure of general scholastic aptitude, the Terman-McNemar Tests of Mental Ability. These measures were administered to the students in their latter months of eighth grade.

Two criteria of academic success were used; grade point averages and scores on the Essential High School Content Battery. Grade point averages in high school majors were computed by averaging teachers' marks in three or more courses within a subject area. The total grade point average, consisting of the average grades of all one-unit courses taken in high school, was used as a criterion of general academic success.

The Essential High School Content Battery was administered during

the latter months of the student's eleventh grade. The four sub-tests of this battery, i.e. English, Social Studies, Science, and Mathematics, were used as alternate criteria of success in these subject areas. The composite score of the EHSCB served as an alternate criterion to total grade point average as a measure of general academic success.

The period of time elapsing between the administration of the predictor tests and the securing of the criterion measures is seen to be at least three years for both criteria.

The senior classes from six Cincinnati Public High Schools formed the original experimental population. In an effort to insure uniformity among the grade point average criteria from school to school, an analysis of covariance technique was used. This technique served to adjust the criterion means relative to the initial ability levels of the students comprising a given school. The A.C.E. Psychological Examination was used as the ability measure in this analysis; it was administered during the mid-year when the students were high school juniors.

Using the same type of covariance technique for each of the subject areas, as well as for total grade point average, three schools were singled out which seemed to grade uniformly. The senior students from these three schools comprised the sample used in the evaluation of the tests as predictors of academic success.

Only those seniors for whom complete test records were available were used as subjects in this study. The final group consisted of a total of 595 students made up of 266 boys and 329 girls.

The statistical techniques used in analyzing the raw data consisted of Pearson product-moment coefficients of correlation and

Student's t-ratio. The former was used as an index of relationship between the predictor and criterion measures, while the latter was used for determining the significance of difference between means of various sub-groups.

Methods of determining the significance of difference between correlation coefficients were also used in addition to the use of Fisher's z-function for averaging correlations.

II. CONCLUSIONS

The conclusions of this study may center around the hypotheses as set forth in CHAPTER I. Each will now be discussed in light of the findings.

1. Hypothesis. Assuming that academic achievement is due largely to a generalized verbal factor, and assuming further that the Terman-McNemar Intelligence Test is a valid measure of this verbal factor, it is hypothesized that this test will be the best all-around predictor of academic success.

This general verbal factor, however, is likely to play a more important role in the prediction of the Essential High School Content Battery criteria, since the latter criteria are probably more dependent upon verbal skills than are the characteristics upon which school marks are based.

Conclusion. For both boys and girls, the Mathematics Proficiency Test proved to be the best predictor of total grade point average. The Terman-McNemar Test of Mental Ability showed the highest correlations with the composite score of the EHSCB.

2. Hypothesis: Since twelfth grade girls probably represent a more heterogeneous population than do twelfth grade boys, it would be expected that the aptitude and achievement predictors would correlate higher with both criteria for girls than they would for boys.

Conclusion. Although tests of significance of difference between individual pairs of correlations did not, in general, prove to be statistically significant, there is little doubt that the cumulative probabilities indicate that the girls represented a more predictable group in terms of predictor test performance, than did boys. In only one case out of seventy-six possible comparisons did boys show a higher correlation between a predictor and the criterion, than girls. This fact is partially explained by the greater heterogeneity of high school girls in comparison to boys.

3. Hypothesis: Due to the more highly verbal nature of the Essential High School Content Battery criteria over the grade point average criteria, it would be expected that much of the difference between these two criteria would be in terms of the degrees to which the verbally loaded measures differentially correlate with them.

Conclusion. On the whole, it was found that the Mathematics Proficiency and Numerical Ability Tests were among the best predictors of grade point averages. Although these tests also proved to be excellent predictors of the EHSCB criteria, in many cases they were displaced by the English Proficiency and Verbal Reasoning Tests.

The Terman-McNemar Test stood as a high predictor of both criteria but proved to be a relatively better predictor of the EHSCB criteria. At least in part, this is probably due to the highly verbal nature of the Terman-McNemar Test.

From this analysis, it appears that grade point average criteria are more highly related to quantitative abilities, while the EHSCB criteria are more highly related to linguistic abilities. The correlations between these two criteria, however, were rather high indicating that both criteria are measures of certain common factors.

4. Hypothesis: Boys would be expected to perform higher on the "number" tests, the Mechanical Reasoning and the Terman-McNemar Intelligence Test, while girls probably would exceed boys on the Spelling, Sentences, English Proficiency and Verbal Reasoning Tests. This hypothesis is based on the findings of numerous studies showing that on the whole, boys exceed girls on quantitative measures while girls generally exceed boys on linguistic measures. Even though the Terman-McNemar Test is verbally oriented, it is nevertheless, a general aptitude test, and since it is expected that the remaining twelfth grade boys represent a more homogeneous and academically select group than do girls it, therefore, would be expected that they would perform higher on this test.

Conclusion. Boys were found to achieve higher than girls on the Verbal Reasoning, Numerical Ability, and the Mechanical Reasoning Tests of the Differential Aptitude Battery. The two groups were not found to differ significantly, however, on the Verbal Reasoning Test. Boys also achieved higher mean scores on the Terman-McNemar Test and the Mathematics Proficiency Test; however, the means of the former test did not prove to be statistically significantly different.

Girls showed higher mean scores than boys on the Spelling, Sentences, and English Proficiency Tests. The differences between boys

and girls on the Spelling and Sentences Tests proved to be significant while the English Proficiency Test means did not show a significant difference.

5. Hypothesis: It is hypothesized that there will be significant differences in mean performances on the aptitude and achievement predictors when students majoring in a subject area are compared to those not majoring in that subject area. This hypothesis results from the notion that , on the whole, the brighter students tend to enter the college preparatory curriculum, i.e. mathematics, science, and foreign language, while the less capable students tend to select other subject areas for majors.

Conclusion. If one accepts the findings stated previously and assumes the existence of a general intelligence factor as being the factor which accounts for the high relationships shown in this study, one may speculate with confidence that students tend to elect certain combinations of majors. Thus, college preparatory students generally elect majors in foreign language, mathematics and/or science. This group generally constitutes the brighter pupils while the less able students tend more toward the vocational subject areas. This would, of course, account for the significance of differences in mean performance of majors and non-majors in a subject area on the predictor tests.

A general ranking of mean performance on the predictor tests shows the foreign language, mathematics and science majors to constitute the highest subject area groups while the industrial arts, home economics and business education majors constitute the lowest ability subject area groups.

III. IMPLICATIONS FOR FURTHER RESEARCH

One of the most outstanding outcomes of this study is the relatively high relationship seen between the predictor tests and the various criteria. For the most part, studies of this type result in correlations between .40 and .60. Why should this particular sample prove to be a more predictable group? Does the answer lie in the nature of the characteristics of the sample group, or in the methods of teaching and administering marks?

If the answer lies in the nature of certain population characteristics, do these characteristics vary from population to population or are they stable? If the answer lies in the methods of teaching and administering marks, what methods are most conducive to high prediction?

Another question which needs further research is why quantitative or "number" measures are better predictors of grade point averages than linguistic measures. Do the rated outcomes of instruction, as reflected by grades, actually depend to a greater extent upon quantitative skills or do the latter simply reflect an aspect of "global" intelligence? Would the answer to this question vary among different levels of intelligence and educational achievement?

A further question arising from this study, and related to the latter question, is whether or not it is fruitful to attempt to isolate so called "special abilities" for purposes of predicting academic success. In other words, is there sufficient differentiation among abilities needed for success in the typical school setting to call for tests of special abilities? It is the writer's opinion that a molar

approach would prove more useful for predictive purposes.

Special abilities, as such, would probably play a subordinate role, in the prediction of academic success, to such factors as general attitudes toward school, subject area and teaching personnel; along with other factors such as interest, motivation and past success.

The question may be raised as to why girls, in general, tended to be a more predictable group, in terms of their high school achievement, than boys. Is this purely a statistical phenomenon, explainable in terms of the greater variance among girls at the twelfth grade level, or is there a genuine difference in the ability to predict boys'and girls'achievement in high school? Further research is necessary to determine the answer to this question.

Due to the relatively high relationships between predictor and criterion variables shown in this study, there is no doubt that the effectiveness and reliability of prediction should be checked. This could be done through the use of cross-validation procedures. Shrinkage would probably result, but to what extent it would occur would have to be determined through further research.

It is apparent that this study has raised as many questions as it has answered.

BIBLIOGRAPHY

A. BOOKS

1. Cronbach, Lee J., Educational Psychology. New York: Harcourt, Brace and Company, 1954.

2. Guilford, J.P., Fundamental Statistics in Psychology and Education. New York: McGraw-Hill Book Company, 1942.

3. Pintner, Rudolf, Intelligence Testing Methods and Results. New York: Henry Holt and Company, 1931.

4. Super, Donald E., Appraising Vocational Fitness. New York: Harper and Brothers, 1948.

5. Thorndike, Robert L., Personnel Selection. New York: John Wiley and Sons, Inc., 1949.

B. PERIODICALS

6. Ames, Viola, "Factors Related to High School Achievement," Journal of Educational Psychology, 34:229-36, April, 1943.

7. Cureton, Edward E., "II. Approximate Linear Restraints and Best Predictor Weights," Symposium: The Need and Means of Cross Validation, Educational and Psychological Measurement, 13:11-16, Spring, 1951.

8. Curtis, Erta A., and Nemzek, Claude L., "The Relation of Certain Unsettled Home Conditions to the Academic Success of High School Pupils," Journal of Social Psychology, 9:419-35, November, 1938.

9. Dodes, I.A., "Prediction of High School Success," High Points, 31:5-14, November, 1949.

10. Douglass, H.R., "Special Methods on High School Level: Mathematics," Review of Educational Research, 2:7-20, 81-82, February, 1932.

11. Embree, Royal B., "Prediction of Senior High School Success at Various Levels of Intelligence," Journal of Educational Psychology, 28:81-91, February, 1937.

12. Finch, F.H., and Nemzek, C.L., "The Relationship of the Bernreuter Personality Inventory to Scholastic Achievement and Intelligence," School and Society, 36:594-96, November, 1932.

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

14. Gough, Harrison G., "Factors Relating to Academic Achievement of High School Students," Journal of Educational Psychology, 40:65-78, February, 1949.

15. Heimann, Robert A., and Schenk, Quentin F., "Relation of Social Class and Sex Differences in High School Achievement," School Review, 62:213-21, April, 1954.

16. Hinkelman, Emmet A., "Relation of Certain Personality Variables to High School Achievement," School Review, 60:532-34, December, 1952.

17. Jordan, A.M., "Correlations of Four Intelligence Tests with Grades," Journal of Educational Psychology, 13:419-29, October, 1922.

18. Kaulfers, Walter V., "Present Status of Prognosis in Foreign Language," School Review, 39:585-96, June, 1931.

19. Lee, J. Murray, and Hughes, W. Hardin, "Predicting Success in Algebra and Geometry," School Review, 42:188-96, March, 1934.

20. Limp, C.E., "A Work in Commercial Prognosis," Journal of Educational Research, 16:46-56, June, 1927.

21. McDaniel, H.B., "The Use of Tests in Guidance," California Guidance Newsletter, 3:3, November, 1949.

22. Mitchell, Blythe C., "The Relation of High School Achievement to the Abilities Measured by the Holzinger-Crowder Uni-Factor Tests," Educational and Psychological Measurement, 15:487-90, Fall, 1955.

23. Mitchell, Claude, "Prognostic Value of Intelligence Tests," Journal of Educational Research, 28:577-81, April, 1935.

24. Nemzek, Claude L., "The Value of Certain Factors for the Direct and Differential Prediction of Academic Success," Journal of Experimental Education, 7:199-202, March, 1939.

25. _____ "The Value of the Bernreuter Personality Inventory for Direct and Differential Prediction of Academic Success as Measured by Teachers' Marks," Journal of Applied Psychology, 22:576-86, December, 1938.

26. _____ "Value of Certain Factors for Direct and Differential Prediction of Academic Success," Journal of Social Psychology, 12:21-30, August, 1940.

27. Ohlson, David, "School Marks and Intelligence," Educational Administration and Supervision, 13:90-102, February, 1927.

28. Powers, S.R., "Intelligence as a Factor in the Selection of High School Subjects," School Review, 30:455, June, 1922.

29. Proctor, William, "Psychological Tests as Means of Measuring the Probable Success of High School Pupils," Journal of Educational Research, 1:258-70, April, 1920.

30. Ross, C.C., and Hooks, W.T., "How Shall We Predict High School Achievement," Journal of Educational Research, 22:184-95, October, 1930.

31. Seagoe, M.V., "Prediction of Achievement in Foreign Language," Journal of Applied Psychology, 22:632-640, December, 1938.

32. Segel, David, "The Validity of a Multiple Aptitude Test at the Secondary Level," Educational and Psychological Measurement, 7:695-705, Spring, 1947.

33. Shaw, Duane C., "A Study of the Relationships Between the Thurstone Primary Mental Abilities and High School Achievement," Journal of Educational Psychology, 40:239-249, April, 1949.

34. Super, Donald E.,"The Bernreuter Personality Inventory: A Review of Research," Psychological Bulletin, 39:94-125, March, 1942

35. Tozer, G.E., "A Statistical Prediction of High School Success for Purposes of Educational Guidance," Journal of Educational Research, 22:399-402, November, 1930.

36. Thorndike, Edward L., "Interests and Abilities," Journal of Applied Psychology, 28:43-52, April, 1944.

37. Townsend, A., "Achievement and Interest Ratings for Independent School Boys," Educational Records Bulletin, 43:49-54, January, 1945.

38. Wesman, Alexander G., "Separation of Sex Groups in Test Reporting," Journal of Educational Psychology, 40:223-224, April, 1949.

39. Whiteley, Sarah S., "Predicting Stenographic Success Through Prognostic Tests," The Balance Sheet, 18:242-44, March, 1932.

40. Wolking, William D., "Predicting Academic Achievement with the Differential Aptitude and the Primary Mental Abilities Tests," Journal of Applied Psychology, 39:115-18, April, 1955.

C. PAMPHLETS AND BULLETINS

41. Committee on Test Standards for the AERA and NCMUE, Technical Recommendations for Achievement Tests (Washington, D.C.: National Education Association, 1955), p.17.

42. Kelly, T.L., Educational Guidance (New York Teachers' College, Contributions to Education, No. 71, New York, 1914), p.116.

43. Miles, W.R., A Comparison of Elementary and High School Grades (University of Iowa, Studies in Education, Vol. 1, No. 1, Iowa City, Iowa, 1911), p.22.

44. Ross, C.C., The Relation Between Grade School Record and High School Achievement (New York Teachers' College, Contributions to Education, No. 166, New York, 1925), p.70.

45. Seashore, Harold G., "Aptitude, Intelligence, and Achievement," Test Service Bulletin, No. 51 (New York: The Psychological Corporation, 1956), p.1.

46. Swineford, Francis and Holzinger, Karl J.,A Study in Factor Analysis: The Reliability of Bi-Factors and Their Relation to Other Measures (University of Chicago, Supplementary Monographs, No. 53).

47. Wesman, Alexander G., A Study of Transfer of Training (New York Teachers' College, Contributions to Education, No. 909, New York, 1945), p.25.

D. ENCYCLOPEDIA ARTICLES

48. Archer, Clifford P., "Student Mortality," Encyclopedia of Educational Research, p. 1158. New York: The Macmillan Company, 1950.

49. Eurich, Alvin C., and Cain, Leo F., "Prognosis in Secondary Schools," Encyclopedia of Educational Research, pp. 844-859. New York: The Macmillan Company, 1941.

E. TEST MANUALS

50. Allen, Richard D., Bixler, Harold H., et.al., "Content of the Series," Metropolitan Achievement Tests: Intermediate and Advanced Arithmetic Tests, p.1. New York: The World Book Company, 1947.

51. American Council on Education, Manual of Directions: American Council on Education Psychological Examination, p.1. Princeton, New Jersey, 1947.

52. Bennett, George, K., Seashore, Harold G., and Wesman, Alexander G., Differential Aptitude Tests, Manual-Second Edition, p.1. New York: The Psychological Corporation, 1952.

53. Harry, David P. and Durost, Walter N., Manual of Directions, Essential High School Content Battery, p.1. New York: The World Book Company, 1951.

54. Terman, Lewis M. and McNemar, Quinn, Construction of the Tests:Terman-McNemar Test of Mental Ability-Manual, p.3. New York: The World Book Company, 1942.

F. DOCTORAL THESES

55. Aaron, Sadie, "The Predictive Value of Cumulative Test Results," Doctor's Thesis. Stanford University, 1946, p.227.

APPENDIX A

TABLE 28

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Total Grade Point Averages

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.5240	5.7350
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.6130	5.2590
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.3389	2.2596
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.4665	3.1102
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.3100	3.6910
B			.8091	- .1006	.0537	.0606	- .0040	.0843	.0345	.9376
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	.0426	1.1588
IV A				1.0000	.6140	.5830	.6850	.3940	.4380	4.9070
B				.6220	.1973	.1163	.2356	.0011	.0698	1.2421
C				1.0000	.3172	.1870	.3788	.0018	.1122	1.9969
V A					1.0000	.6590	.6870	.5400	.5440	5.5960
B					.4433	.0686	.0924	.0670	.0881	.7594
C					1.0000	.1547	.2084	.1511	.1987	1.7130
VI A						1.0000	.8360	.5750	.5820	5.9560
B						.3447	.1922	.0545	.0818	.6733
C						1.0000	.5576	.1581	.2373	1.9533
VII A							1.0000	.5640	.5390	5.8720
B							.2295	.0455	.0046	.2797
C							1.0000	.1983	.0200	1.2187
VIII A								1.0000	.6570	5.3910
B								.3849	.1309	.5160
C								1.0000	.3401	1.3406
							1.0000		-.0474	
						1.0000			.2100	
					1.0000				.1247	
				1.0000					.0507	
			1.0000						-.0108	
		1.0000							.1786	
	1.0000								.0138	

Table 29

Doolittle Solution for the Beta Coefficients of Eight Tests
for Predicting Girls Total Grade Point Averages

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.5960	6.1700
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.6860	6.0640
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.3010	2.0782
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.5166	3.5665
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.4370	4.8040
B			.6444	- .0294	.0725	.0425	.0273	.0102	.0157	.7830
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.0244	1.2151
IV A				1.0000	.6430	.6250	.7210	.5670	.5820	5.5090
B				.6602	.2453	.1494	.2915	.1019	.1742	1.6237
C				1.0000	.3715	.2261	.4413	.1545	.2638	2.4590
V A					1.0000	.6730	.7040	.6320	.5880	5.9680
B					.4246	.0435	.0801	.0463	.0434	.6377
C					1.0000	.1024	.1886	.1090	.1022	1.5019
VI A						1.0000	.8380	.7370	.6610	6.5390
B						.2735	.1468	.0694	.0571	.5471
C						1.0000	.5367	.2537	.2089	2.0010
VII A							1.0000	.7270	.6380	6.4290
B							.2232	.0544	.0133	.2904
C							1.0000	.2437	.0596	1.3011
VIII A								1.0000	.7160	6.3370
B								.2801	.0822	.3618
C								1.0000	.2936	1.2921
							1.0000		-.0122	
						1.0000			.2004	
					1.0000				.0474	
				1.0000					.1501	
			1.0000						.0076	
		1.0000							.2260	
	1.0000								-.0353	

Table 30

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in English

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math. Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.5680	6.1420
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.6610	6.0390
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.2941	2.0713
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.5047	3.5547
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.4110	4.7780
B			.6444	- .0294	.0725	.0425	.0273	.0102	.0071	.7745
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.0110	1.2019
IV A				1.0000	.6430	.6250	.7210	.5670	.5700	5.4970
B				.6602	.2453	.1494	.2915	.1019	.1802	1.6284
C				1.0000	.3715	.2261	.4413	.1545	.2729	2.4665
V A					1.0000	.6730	.7040	.6320	.5840	5.9640
B					.4246	.0435	.0801	.0463	.0584	.6531
C					1.0000	.1024	.1886	.1090	.1376	1.5381
VI A						1.0000	.8380	.7370	.6870	6.5650
B						.2735	.1468	.0694	.1051	.5949
C						1.0000	.5367	.2537	.3843	2.1751
VII A							1.0000	.7270	.6470	6.4380
B							.2232	.0544	.0133	.2907
C							1.0000	.2437	.0596	1.3024
VIII A								1.0000	.6900	6.3110
B								.2801	.0648	.3450
C								1.0000	.2313	1.2317
							1.0000		.0032	
						1.0000			.3239	
					1.0000				.0786	
				1.0000					.1333	
			1.0000						-.0169	
		1.0000							.2238	
	1.0000								-.1101	

Table 31

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in English

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math. Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.4960	5.7070
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.4990	5.1450
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.2396	2.1602
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.3298	2.9734
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.1250	3.5060
B			.8091	- .1006	.0537	.0606	- .0040	.0843	-.1211	.7820
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	-.1497	.9665
IV A				1.0000	.6140	.5830	.6850	.3940	.4480	4.9170
B				.6220	.1973	.1163	.2356	.0011	.0969	1.2692
C				1.0000	.3172	.1870	.3788	.0018	.1558	2.0405
V A					1.0000	.6590	.6870	.5400	.4550	5.5070
B					.4433	.0686	.0924	.0670	.0431	.7144
C					1.0000	.1547	.2084	.1511	.0972	1.6115
VI A						1.0000	.8360	.5750	.5200	5.8900
B						.3447	.1922	.0545	.0751	.6665
C						1.0000	.5576	.1581	.2179	1.9336
VII A							1.0000	.5640	.5140	5.8470
B							.2295	.0455	.0205	.2956
C							1.0000	.1983	.0893	1.2880
VIII A								1.0000	.5200	5.2540
B								.3849	.0929	.4780
C								1.0000	.2414	1.2418
							1.0000		.0414	
						1.0000			.1567	
					1.0000				.0279	
				1.0000					.1015	
			1.0000						-.1756	
		1.0000							.1413	
	1.0000								.1372	

Table 32

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in Social Studies

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.4850	5.6960
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.4950	5.1410
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.2413	2.1620
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.3321	2.9759
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.1990	3.5800
B			.8091	- .1006	.0537	.0606	- .0040	.0843	-.0429	.8602
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	-.0530	1.0632
IV A				1.0000	.6140	.5830	.6850	.3940	.3610	4.8300
B				.6220	.1973	.1163	.2356	.0011	.0256	1.1979
C				1.0000	.3172	.1870	.3788	.0018	.0412	1.9259
V A					1.0000	.6590	.6870	.5400	.4810	5.5330
B					.4433	.0686	.0924	.0670	.0935	.7647
C					1.0000	.1547	.2084	.1511	.2109	1.7250
VI A						1.0000	.8360	.5750	.5530	5.9230
B						.3447	.1922	.0545	.1158	.7073
C						1.0000	.5576	.1581	.3359	2.0519
VII A							1.0000	.5640	.5280	5.8610
B							.2295	.0455	.0364	.3114
C							1.0000	.1983	.1586	1.3569
VIII A								1.0000	.5380	5.2720
B								.3849	.0905	.4755
C								1.0000	.2351	1.2354
							1.0000		.1120	
						1.0000			.2363	
					1.0000				.1155	
				1.0000					.1237	
			1.0000						-.0869	
		1.0000							.0771	
	1.0000								-.0572	

Table 33

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in Social Studies

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.5540	6.1280
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.5540	5.9320
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.1961	1.9733
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.3365	3.3865
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.3890	4.7560
B			.6444	- .0294	.0725	.0425	.0273	.0102	.0248	.7922
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.0385	1.2295
IV A				1.0000	.6430	.6250	.7210	.5670	.5040	5.4310
B				.6602	.2453	.1494	.2915	.1019	.1504	1.5986
C				1.0000	.3715	.2261	.4413	.1545	.2278	2.4214
V A					1.0000	.6730	.7040	.6320	.5510	5.9310
B					.4246	.0435	.0801	.0463	.0730	.6680
C					1.0000	.1024	.1886	.1090	.1719	1.5729
VI A						1.0000	.8380	.7370	.6320	6.5100
B						.2735	.1468	.0694	.0917	.5814
C						1.0000	.5367	.2537	.3353	2.1258
VII A							1.0000	.7270	.5950	6.3860
B							.2232	.0544	.0153	.2929
C							1.0000	.2437	.0685	1.3123
VIII A								1.0000	.6330	6.2540
B								.2801	.0810	.3608
C								1.0000	.2893	1.2886
							1.0000		-.0021	
						1.0000			.2630	
					1.0000				.1137	
				1.0000					.0823	
			1.0000						.0076	
		1.0000							.0351	
	1.0000								.0023	

Table 34.

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in Science

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.4930	5.7040
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.5270	5.1730
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.2692	2.1898
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.3705	3.0142
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.4380	3.8190
B			.8091	- .1006	.0537	.0606	- .0040	.0843	.1878	1.0909
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	.2321	1.3483
IV A				1.0000	.6140	.5830	.6850	.3940	.3080	4.7770
B				.6220	.1973	.1163	.2356	.0011	-.0090	1.1633
C				1.0000	.3172	.1870	.3788	.0018	-.0145	1.8703
V A					1.0000	.6590	.6870	.5400	.5010	5.5530
B					.4433	.0686	.0924	.0670	.0972	.7685
C					1.0000	.1547	.2084	.1511	.2193	1.7336
VI A						1.0000	.8360	.5750	.5410	5.9110
B						.3447	.1922	.0545	.0807	.6721
C						1.0000	.5576	.1581	.2341	1.9498
VII A							1.0000	.5640	.5090	5.8420
B							.2295	.0455	.0394	.3145
C							1.0000	.1983	.1717	1.3703
VIII A								1.0000	.6210	5.3610
B								.3849	.1379	.5229
C								1.0000	.3583	1.3585
							1.0000		.1006	
						1.0000			.1214	
					1.0000				.1254	
				1.0000					.1157	
			1.0000						.1922	
		1.0000							.0117	
	1.0000								-.1005	

Table 35

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in Science

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.5710	6.1450
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.5820	5.9600
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.2131	1.9903
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.3657	3.4157
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.4220	4.7890
B			.6444	- .0294	.0725	.0425	.0273	.0102	.0431	.8104
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.0669	1.2578
IV A				1.0000	.6430	.6250	.7210	.5670	.5260	5.4530
B				.6602	.2453	.1494	.2915	.1019	.1592	1.6074
C				1.0000	.3715	.2261	.4413	.1545	.2411	2.4347
V A					1.0000	.6730	.7040	.6320	.5240	5.9040
B					.4246	.0435	.0801	.0463	.0245	.6191
C					1.0000	.1024	.1886	.1090	.0577	1.4580
VI A						1.0000	.8380	.7370	.6510	6.5290
B						.2735	.1468	.0694	.0943	.5841
C						1.0000	.5367	.2537	.3448	2.1356
VII A							1.0000	.7270	.5900	6.3810
B							.2232	.0544	-.0035	.2740
C							1.0000	.2437	-.0157	1.2276
VIII A								1.0000	.6630	6.2840
B								.2801	.0969	.3770
C								1.0000	.3459	1.3459
							1.0000		.1000	
						1.0000			.2034	
					1.0000				-.0197	
				1.0000					.1049	
			1.0000						.0508	
		1.0000							.0379	
	1.0000								.0042	

Table 36

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in Math

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.3790	5.5900
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.4950	5.1410
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.2968	2.2174
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.4085	3.0522
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.2710	3.6520
B			.8091	- .1006	.0537	.0606	- .0040	.0843	.0624	.9655
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	.0771	1.1933
IV A				1.0000	.6140	.5830	.6850	.3940	.4010	4.8700
B				.6220	.1973	.1163	.2356	.0011	.1288	1.3011
C				1.0000	.3172	.1870	.3788	.0018	.2071	2.0918
V A					1.0000	.6590	.6870	.5400	.4280	5.4800
B					.4433	.0686	.0924	.0670	.0588	.7301
C					1.0000	.1547	.2084	.1511	.1326	1.6469
VI A						1.0000	.8360	.5750	.4330	5.8030
B						.3447	.1922	.0545	.0440	.6355
C						1.0000	.5576	.1581	.1276	1.8436
VII A							1.0000	.5640	.4080	5.7410
B							.2295	.0455	-.0080	.2670
C							1.0000	.1983	-.0348	1.1634
VIII A								1.0000	.6100	5.3440
B								.3849	.1980	.5831
C								1.0000	.5144	1.5149
							1.0000		-.1529	
						1.0000			.1315	
					1.0000				.0664	
				1.0000					.2184	
			1.0000						.0356	
		1.0000							.0165	
	1.0000								-.0794	

Table 37

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in Math

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.5660	6.1400
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.6540	6.0320
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.2884	2.0656
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.4949	3.5449
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.5060	4.8730
B			.6444	- .0294	.0725	.0425	.0273	.0102	.1050	.8724
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.1629	1.3538
IV A				1.0000	.6430	.6250	.7210	.5670	.6240	5.5510
B				.6602	.2453	.1494	.2915	.1019	.2414	1.6896
C				1.0000	.3715	.2261	.4413	.1545	.3656	2.5592
V A					1.0000	.6730	.7040	.6320	.5660	5.9460
B					.4246	.0435	.0801	.0463	.0098	.6043
C					1.0000	.1024	.1886	.1090	.0231	1.4232
VI A						1.0000	.8380	.7370	.6220	6.5000
B						.2735	.1468	.0694	.0280	.5177
C						1.0000	.5367	.2537	.1024	1.8929
VII A							1.0000	.7270	.6170	6.4080
B							.2232	.0544	.0056	.2832
C							1.0000	.2437	.0251	1.2688
VIII A								1.0000	.6710	6.2920
B								.2801	.0663	.3464
C								1.0000	.2367	1.2367
							1.0000		-.0326	
						1.0000			.0598	
					1.0000				-.0027	
				1.0000					.3309	
			1.0000						.1720	
		1.0000							.1981	
	1.0000								-.0179	

Table 38

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in Language

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.0510	5.2620
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.4850	5.1310
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.4583	2.3790
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.6308	3.2747
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.2190	3.6000
B			.8091	- .1006	.0537	.0606	- .0040	.0843	.1154	1.0185
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	.1426	1.2588
IV A				1.0000	.6140	.5830	.6850	.3940	.0320	4.5010
B				.6220	.1973	.1163	.2356	.0011	-.0767	1.0956
C				1.0000	.3172	.1870	.3788	.0018	-.1233	1.7614
V A					1.0000	.6590	.6870	.5400	.0190	5.0710
B					.4433	.0686	.0924	.0670	-.1065	.5648
C					1.0000	.1547	.2084	.1511	-.2402	1.2741
VI A						1.0000	.8360	.5750	-.0230	5.3470
B						.3447	.1922	.0545	-.1332	.4582
C						1.0000	.5576	.1581	-.3864	1.3293
VII A							1.0000	.5640	-.0460	5.2870
B							.2295	.0455	-.0417	.2333
C							1.0000	.1983	-.1817	1.0166
VIII A								1.0000	.4110	5.1450
B								.3849	.1261	.5110
C								1.0000	.3276	1.3276
							1.0000		-.2467	
						1.0000			-.3006	
					1.0000				-.1918	
				1.0000					.0866	
			1.0000						.1533	
		1.0000							.5293	
	1.0000								.0259	

Table 39

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in Language

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.4210	5.9950
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.6330	6.0110
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.3610	2.1382
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.6195	3.6695
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.2190	4.5860
B			.6444	- .0294	.0725	.0425	.0273	.0102	-.1274	.6400
C			1.0000	- .0456	.1125	.0660	.0424	.0158	-.1977	.9932
IV A				1.0000	.6430	.6250	.7210	.5670	.6370	5.5640
B				.6602	.2453	.1494	.2915	.1019	.3015	1.7497
C				1.0000	.3715	.2261	.4413	.1545	.4567	2.6502
V A					1.0000	.6730	.7040	.6320	.4980	5.8780
B					.4246	.0435	.0801	.0463	.0181	.6128
C					1.0000	.1024	.1886	.1090	.0427	1.4432
VI A						1.0000	.8380	.7370	.5390	6.4170
B						.2735	.1468	.0694	.0425	.5323
C						1.0000	.5367	.2537	.1554	1.9462
VII A							1.0000	.7270	.5170	6.3080
B							.2232	.0544	-.0371	.2404
C							1.0000	.2437	-.1662	1.0771
VIII A								1.0000	.6280	6.2490
B								.2801	.0793	.3594
C								1.0000	.2831	.12831
							1.0000		-.2294	
						1.0000			.2067	
					1.0000				.0339	
				1.0000					.4549	
			1.0000						-.1892	
		1.0000							.3792	
	1.0000								-.1843	

Table 40

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Boys Grade Point Averages in Industrial Arts

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I	1.0000	.5230	.4090	.5790	.6710	.7670	.7280	.5340	.2680	5.4790
II A		1.0000	.3450	.4510	.5220	.5490	.5150	.7410	.2220	4.8680
B		.7265	.1311	.1482	.1711	.1479	.1343	.4617	.0818	2.0025
C		1.0000	.1804	.2040	.2355	.2036	.1849	.6355	.1127	2.7564
III A			1.0000	.1630	.3590	.4010	.3180	.3860	.1940	3.5750
B			.8091	- .1006	.0537	.0606	- .0040	.0843	.0696	.9727
C			1.0000	- .1243	.0664	.0749	- .0049	.1042	.0860	1.2022
IV A				1.0000	.6140	.5830	.6850	.3940	.3220	4.7910
B				.6220	.1973	.1163	.2356	.0011	.1588	1.3311
C				1.0000	.3172	.1870	.3788	.0018	.2553	2.1400
V A					1.0000	.6590	.6870	.5400	.3070	5.3590
B					.4433	.0686	.0924	.0670	.0529	.7242
C					1.0000	.1547	.2084	.1511	.1193	1.6336
VI A						1.0000	.8360	.5750	.3070	5.6770
B						.3447	.1922	.0545	.0417	.6331
C						1.0000	.5576	.1581	.1210	1.8367
VII A							1.0000	.5640	.2900	5.6230
B							.2295	.0455	-.0143	.2608
C							1.0000	.1983	-.0623	1.1364
VIII A								1.0000	.3640	5.0980
B								.3849	.1496	.5346
C								1.0000	.3887	1.3889
							1.0000		-.1394	
						1.0000			.1373	
					1.0000				.0684	
				1.0000					.2732	
			1.0000						.0639	
		1.0000							-.2199	
	1.0000								-.0586	

Table 41

Doolittle Solution for the Beta Coefficients of Eight Tests for Predicting Girls Grade Point Averages in Home Economics

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.3590	5.9330
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.4860	5.8640
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.2541	2.0313
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.4361	3.4860
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.1670	4.5340
B			.6444	- .0294	.0725	.0425	.0273	.0102	-.1107	.6567
C			1.0000	- .0456	.1125	.0660	.0424	.0158	-.1718	1.0191
IV A				1.0000	.6430	.6250	.7210	.5670	.2150	5.1420
B				.6602	.2453	.1494	.2915	.1019	-.0560	1.3922
C				1.0000	.3715	.2261	.4413	.1545	-.0848	2.1087
V A					1.0000	.6730	.7040	.6320	.4150	5.7950
B					.4246	.0435	.0801	.0463	.1385	.7332
C					1.0000	.1024	.1886	.1090	.3262	1.7268
VI A						1.0000	.8380	.7370	.5110	6.3890
B						.2735	.1468	.0694	.1604	.6503
C						1.0000	.5367	.2537	.5865	2.3777
VII A							1.0000	.7270	.4890	6.2800
B							.2232	.0544	.0798	.3573
C							1.0000	.2437	.3575	1.6008
VIII A								1.0000	.4090	6.0300
B								.2801	-.0508	- .2293
C								1.0000	-.1814	.8186
							1.0000		.4017	
						1.0000			.4169	
					1.0000				.2275	
				1.0000					-.4128	
			1.0000						-.2203	
		1.0000							.4413	
	1.0000								-.2293	

Table 42

Doolittle Solution for the Beta Coefficients of Eight Tests
for Predicting Girls Grade Point Averages in Business Education

	Verb. Reas.	Num. Abil.	Mech. Reas.	Spell.	Sent.	Terman I.Q.	Eng. Prof.	Math Prof.	Crit.	Check
I A	1.0000	.6460	.5410	.5400	.6510	.8020	.7130	.6810	.3900	5.9640
II A		1.0000	.5410	.5140	.5950	.6750	.6220	.7850	.5250	5.9030
B		.5827	.1915	.1652	.1745	.1569	.1614	.3451	.2731	2.0503
C		1.0000	.3286	.2835	.2995	.2693	.2770	.5922	.4687	3.5186
III A			1.0000	.3170	.4820	.5280	.4660	.4920	.3300	4.6970
B			.6444	- .0294	.0725	.0425	.0273	.0102	.0293	.7967
C			1.0000	- .0456	.1125	.0660	.0424	.0158	.0455	1.2363
IV A				1.0000	.6430	.6250	.7210	.5670	.4030	5.3300
B				.6602	.2453	.1494	.2915	.1019	.1163	1.5645
C				1.0000	.3715	.2261	.4413	.1545	.1762	2.3697
V A					1.0000	.6730	.7040	.6320	.3710	5.7510
B					.4246	.0435	.0801	.0463	-.0112	.5835
C					1.0000	.1024	.1886	.1090	-.0264	1.3742
VI A						1.0000	.8380	.7370	.4660	6.3440
B						.2735	.1468	.0694	.0526	.5424
C						1.0000	.5367	.2537	.1923	1.9831
VII A							1.0000	.7270	.4560	6.2470
B							.2232	.0544	.0236	.3011
C							1.0000	.2437	.1057	1.3490
VIII A								1.0000	.5710	6.1920
B								.2801	.1074	.3875
C								1.0000	.3834	1.3834
							1.0000		.0123	
						1.0000			.0884	
					1.0000				-.0796	
				1.0000					.1211	
			1.0000						.0476	
		1.0000							.1883	
	1.0000								-.1117	

APPENDIX B

TABLE 43

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN ENGLISH FOR BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	.1372	.496	.0680	.0896	.0123	16.35	-.2011
Num. Ability	.1413	.499	.0705	.1021	.0144	16.00	-.2304
Mech. Reas.	-.1756	.125	-.0219	.0587	-.0103	35.38	.3644
Spelling	.1015	.448	..0454	.0323	.0033	25.44	-.0840
Sentences	.0279	.455	.0126	.0532	.0015	19.94	-.0299
Terman I.Q.	.1567	.520	.0814	.0506	.0079	109.98	-.8688
Eng. Prof.	.0414	.514	.0212	.0308	.0013	100.95	-.1312
Math Prof.	.2414	.520	.1255	.0400	.0097	58.44	-.5669
			$.4030=R^2$				ϵ =-1.7479
			.635=R				M_1= 2.0640
							a = .3161
			Girls				
Verbal Reas.	-.1101	.568	-.0625	.0975	-.0107	15.96	.1708
Num. Ability	.2238	.661	.1479	.1132	.0235	14.59	-.3691
Mech. Reas.	-.0169	.411	-.0069	.0743	-.0013	23.11	.0300
Spelling	.1333	.570	.0759	.0316	.0042	33.53	-.1408
Sentences	.0786	.584	.0459	.0583	.0046	24.47	-.1126
Terman I.Q.	.3239	.687	.2225	.0528	.0171	107.72	-.8420
Eng. Prof.	.0032	.647	.0020	.0329	.0001	104.06	-.0104
Math Prof.	.2313	.690	.1595	.0436	.0101	54.42	-.5496
			$.5845=R^2$				ϵ =-2.8234
			.765=R				M_1= 2.3888
							a = -.4349

TABLE 44

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN SOCIAL STUDIES FOR BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	-.0572	.485	-.0277	.0984	-.0056	15.43	.0864
Num. Ability	.0771	.495	.0382	.1160	.0089	14.81	-.1318
Mech. Reas.	-.0869	.199	-.0173	.0629	-.0055	33.81	.1860
Spelling	.1237	.361	.0447	.0376	.0047	26.13	-.1228
Sentences	.1155	.481	.0556	.0601	.0069	18.17	-.1254
Terman I.Q.	.2363	.553	.1307	.0554	.0131	107.85	-1.4128
Eng. Prof.	.1120	.528	.0591	.0330	.0037	97.40	-.3604
Math Prof.	.2351	.538	.1265	.0466	.0110	55.29	-.6082
			$.4098=R^2$				ϵ =-2.2190
			.640 =R				M_1= 2.1310
							a = -.0880
			Girls				
Verbal Reas.	.0023	.554	.0013	.1003	.0002	14.70	-.0029
Num. Ability	.0351	.554	.0194	.1193	.0042	13.28	-.0558
Mech. Reas.	.0076	.389	.0030	.0746	.0006	21.69	-.0130
Spelling	.0823	.504	.0415	.0322	.0027	30.05	-.0811
Sentences	.1137	.551	.0626	.0578	.0066	21.69	-.1449
Terman I.Q.	.2630	.632	.1662	.0523	.0137	105.09	-1.4397
Eng. Prof.	-.0021	.595	-.0012	.0323	-.0001	99.95	.0100
Math Prof.	.2893	.633	.1831	.0433	.0125	50.71	-.6339
			$.4783=R^2$				ϵ =-2.3813
			.692 =R				M_1= 2.1780
							a = -.2033

TABLE 45

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN SCIENCE FOR BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	-.1005	.493	-.0495	.0966	-.0097	17.35	.1684
Num. Ability	.0117	.527	.0062	.1124	.0013	16.98	-.0221
Mech. Reas.	.1922	.438	.0842	.0641	.0123	36.68	-.4512
Spelling	.1157	.308	.0356	.0333	.0039	27.39	-.1068
Sentences	.1254	.501	.0628	.0575	.0072	22.02	-.1585
Terman I.Q.	.1214	.541	.0657	.0569	.0069	111.90	-.7721
Eng. Prof.	.1006	.509	.0512	.0352	.0035	103.92	-.3637
Math Prof.	.3583	.621	.2225	.0421	.0151	60.07	-.9070
			$.4787=R^2$				ϵ =-2.6130
			.692 =R				M_1= 2.3800
							a = -.2330
			Girls				
Verbal Reas.	.0042	.571	.0024	.0900	.0004	18.12	-.0072
Num. Ability	.0379	.582	.0221	.1017	.0039	16.09	-.0628
Mech. Reas.	.0508	.422	.0214	.0684	.0035	24.91	-.0872
Spelling	.1049	.526	.0552	.0293	.0031	35.91	-.1113
Sentences	-.0197	.524	-.0103	.0543	-.0011	26.80	.0295
Terman I.Q.	.2034	.651	.1324	.0510	.0104	112.09	-1.1657
Eng. Prof.	.1000	.590	.0590	.0320	.0032	108.98	-.3498
Math Prof.	.3459	.663	.2293	.0515	.0144	58.34	-.8401
			$.5115=R^2$				ϵ =-2.5935
			.715 =R				M_1= 2.441
							a = -.1525

TABLE 46

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN MATHEMATICS FOR BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_K	b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	-.0794	.379	-.0301	.1244	-.0099	17.08	.1691
Num. Ability	.0165	.495	.0082	.1290	.0021	17.50	-.0368
Mech. Reas.	.0356	.271	.0096	.0845	.0030	38.57	-.1160
Spelling	.2184	.401	.0876	.0436	.0095	23.17	-.2201
Sentences	.0664	.428	.0284	.0683	.0045	22.38	-.1007
Terman I.Q.	.1315	.433	.0569	.0706	.0093	112.20	-1.0435
Eng. Prof.	-.1529	.408	-.0624	.0452	-.0069	104.55	.7214
Math Prof.	.5144	.610	.3138	.0505	.0260	61.28	-1.5933
			$.4120=R^2$				ϵ =-2.2199
			.642 =R				M_1= 2.1350
							a = -.0849
			Girls				
Verbal Reas.	-.0179	.566	-.0101	.0892	-.0016	21.55	.0345
Num. Ability	.1981	.654	.1296	.1206	.0239	20.21	-.4830
Mech. Reas.	.1720	.506	.0870	.0862	.0148	29.42	-.4354
Spelling	.3309	.624	.2065	.0303	.0100	44.90	-.4490
Sentences	-.0027	.566	-.0015	.0623	-.0002	31.96	.0064
Terman I.Q.	.0598	.622	.0372	.0677	.0040	118.41	-.4736
Eng. Prof.	-.0326	.617	-.0201	.0429	-.0014	118.11	.1654
Math Prof.	.2367	.671	.1588	.0571	.0135	68.66	-.9269
			$.5874=R^2$				ϵ =-2.5616
			.766 =R				M_1= 2.770
							a = .2084

TABLE 47

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF LANGUAGE GRADE POINT AVERAGES FOR BOYS AND GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
			Boys				
Verbal Reas.	-.0259	.051	-.0013	.0814	.0021	21.85	-.0459
Num. Ability	.5293	.485	.2567	.0974	.0516	19.61	-1.0119
Mech. Reas.	.1533	.219	.0336	.0563	.0086	37.15	-.3195
Spelling	.0866	.032	.0028	.0289	.0026	43.15	-.1122
Sentences	-.1918	.019	-.0036	.0522	-.0100	28.06	.2806
Terman I.Q.	-.3006	-.023	.0069	.0570	-.0171	119.70	2.0469
Eng. Prof.	-.2467	-.046	.0113	.0452	-.0112	120.48	1.3494
Math Prof.	.3276	.411	.1346	.0592	.0194	70.18	-1.3615
			.4445=R^2				$\mathcal{L}$ = .8259
			.666 =R				M_1 = 2.6890
							a = 3.5149
			Girls				
Verbal Reas.	-.1843	.421	-.0776	.0843	-.0155	22.51	.3489
Num. Ability	.3792	.633	.2400	.1129	.0428	20.48	-.8765
Mech. Reas.	-.1892	.219	-.0414	.0761	-.0144	29.05	.4183
Spelling	.4549	.637	.2898	.0270	.0123	49.06	-.6034
Sentences	.0339	.498	.0169	.0570	.0019	34.06	-.0647
Terman I.Q.	.2067	.539	.1114	.0531	.0110	119.68	-1.3165
Eng. Prof.	-.2294	.517	-.1186	.0349	-.0080	119.16	.9533
Math Prof.	.2831	.628	.1778	.0510	.0144	67.84	-.9769
			.5983=R^2				$\mathcal{L}$ =-2.1175
			.774 =R				M_1 = 2.9100
							a = .7925

TABLE 48

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN INDUSTRIAL ARTS FOR BOYS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_k	b_{1k}	M_k	$(-M_k)b_{1k}$
Verbal Reas.	-.0586	.268	-.0157	.1647	-.0097	12.51	.1213
Num. Ability	-.2199	.222	-.0488	.1656	-.0364	13.64	.4965
Mech. Reas.	.0639	.194	.0124	.0837	.0053	32.48	-.1721
Spelling	.2732	.322	.0880	.0638	.0174	17.68	-.3076
Sentences	.0684	.307	.0210	.0964	.0066	12.31	-.0812
Terman I.Q.	.1373	.307	.0422	.0840	.0115	103.09	-1.1855
Eng. Prof.	-.1394	.290	-.0404	.0465	-.0065	88.44	.5749
Math Prof.	.3887	.364	.1415	.0585	.0227	52.08	-1.1822
			$.2002=R^2$				$\mathcal{L}$ = -1.7359
			.448 =R				M_1 = 2.7030
							a = .9671

TABLE 49

SOLUTION OF THE REGRESSION COEFFICIENTS AND MULTIPLE CORRELATION FOR THE PREDICTION OF GRADE POINT AVERAGES IN HOME ECONOMICS FOR GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_K	b_{1k}	M_k	$(-M_k)b_{1k}$
Verbal Reas.	-.2293	.359	-.0823	.1306	-.0299	11.12	.3325
Num. Ability	.4413	.486	.2145	.1154	.0509	10.41	-.5299
Mech. Reas.	-.2203	.167	-.0368	.0707	-.0156	17.29	.2697
Spelling	-.4128	.215	-.0888	.0363	-.0150	20.71	.3107
Sentences	.2275	.415	.0944	.0548	.0125	18.65	-.2331
Terman I.Q.	.4169	.511	.2130	.0576	.0240	97.30	-2.3352
Eng. Prof.	.4017	.489	.1964	.0303	.0122	89.20	-1.1882
Math Prof.	-.1814	.409	-.0742	.0343	-.0062	43.63	.2705
			$.4362=R^2$				$\mathcal{E}$ = -3.0030
			.660 =R				M_1 = 2.4910
							a = -.5120

TABLE 50

SOLUTION OF THE REGRESSION COEFFICIENTS FOR THE PREDICTION OF GRADE POINT AVERAGES IN BUSINESS EDUCATION FOR GIRLS

Predictor Variable	B_{1k}	r_{1k}	$B_{1k}r_{1k}$	σ_1/σ_M	b_{1k}	M_k	$(-M_k)b_{1k}$
Verbal Reas.	-.1117	.390	-.0436	.0933	-.0104	13.59	.1413
Num. Ability	.1883	.525	.0989	.1084	.0204	12.97	-.2646
Mech. Reas.	.0476	.330	.0157	.0638	.0030	20.24	-.0607
Spelling	.1211	.403	.0488	.0281	.0034	29.08	-.0989
Sentences	-.0796	.371	.0295	.0525	-.0042	20.71	.0870
Terman I.Q.	.0884	.466	.0412	.0469	.0041	102.82	-.4216
Eng. Prof.	.0123	.456	.0056	.0267	.0003	97.98	-.0294
Math Prof.	.3834	.571	.2189	.0385	.0148	49.92	-.7388
			$.4150=R^2$				ϵ =-1.3857
			.644 =R				M_1 = 2.2270
							a = .8413

APPENDIX C

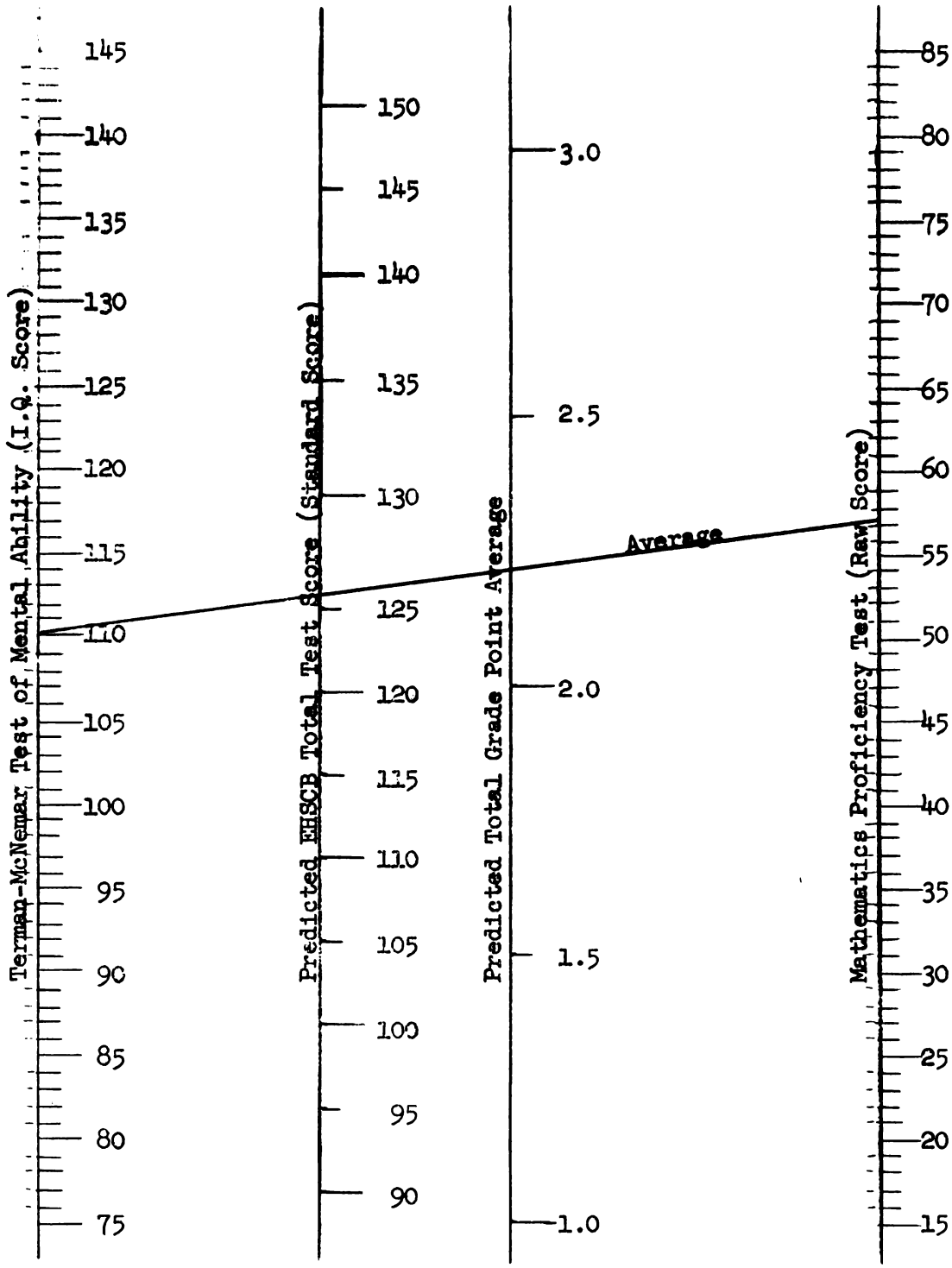

Figure 1

A Nomograph for the Prediction of Boy's Total Grade Point Average and Total Score on the EHSCB from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Tests

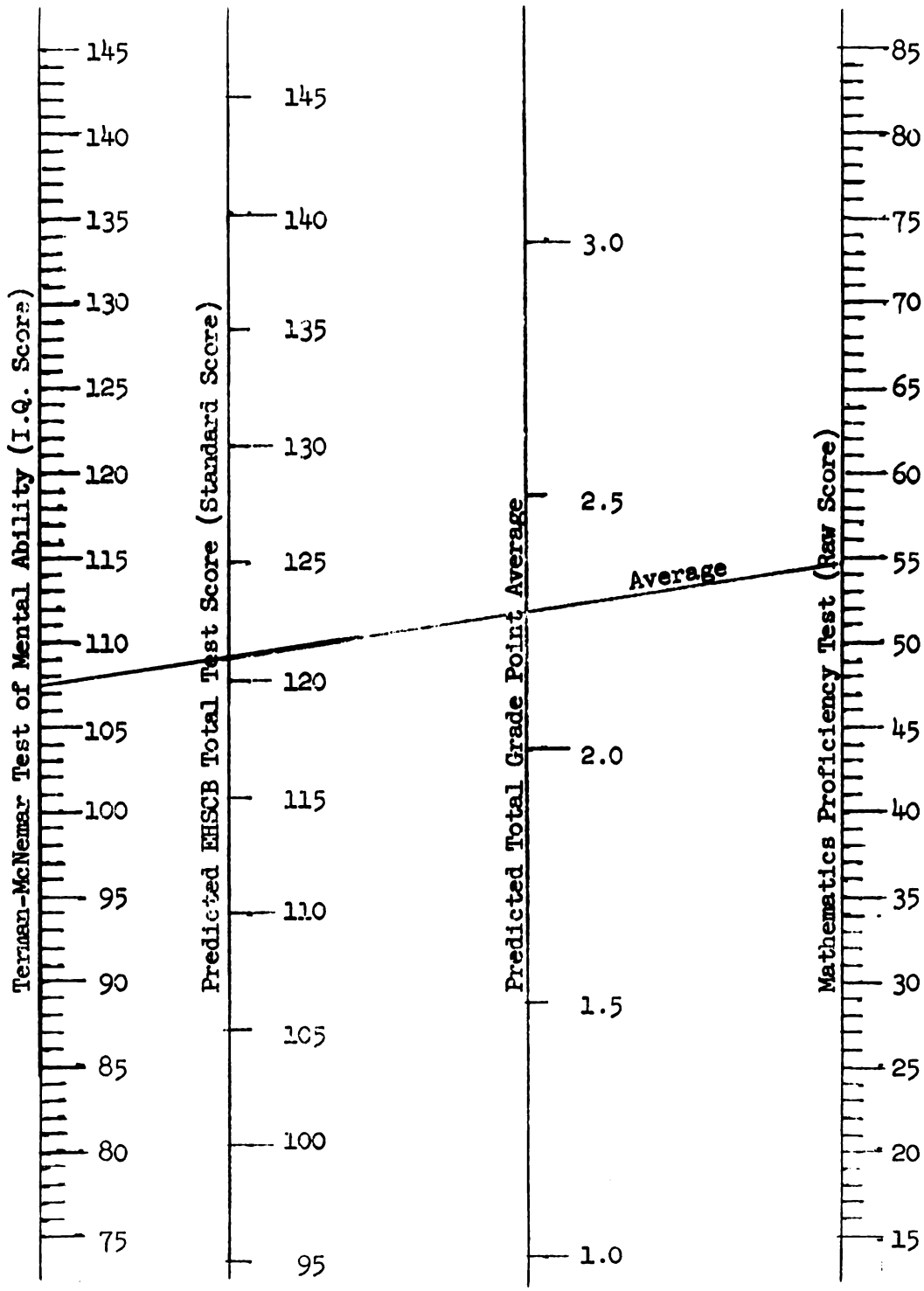

Figure 2

A Nomograph for the Prediction of Girl's Total Grade Point Average and the Total Score on the EHSCB from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

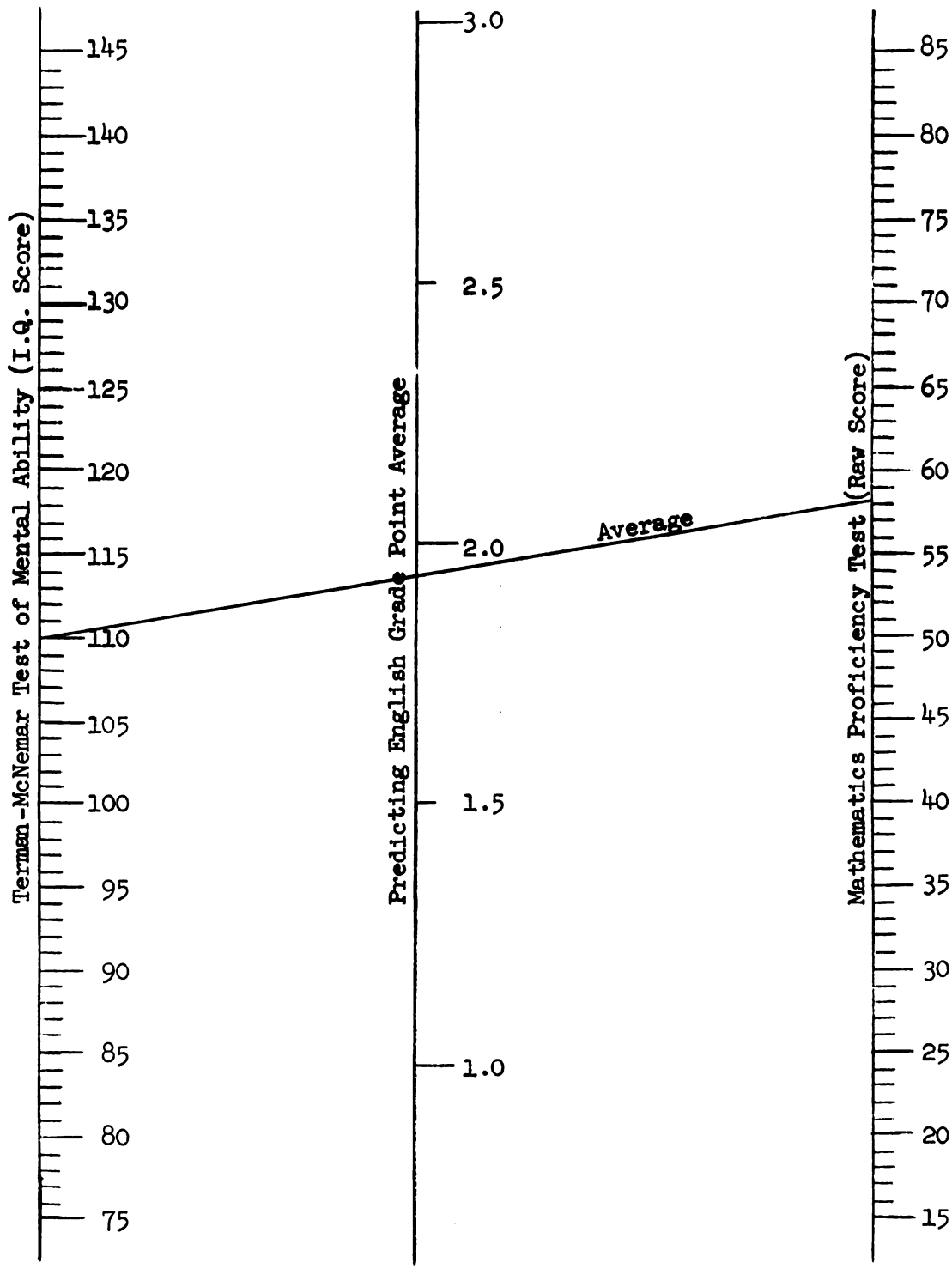

Figure 3

A Nomograph for Predicting Boys English Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Tests

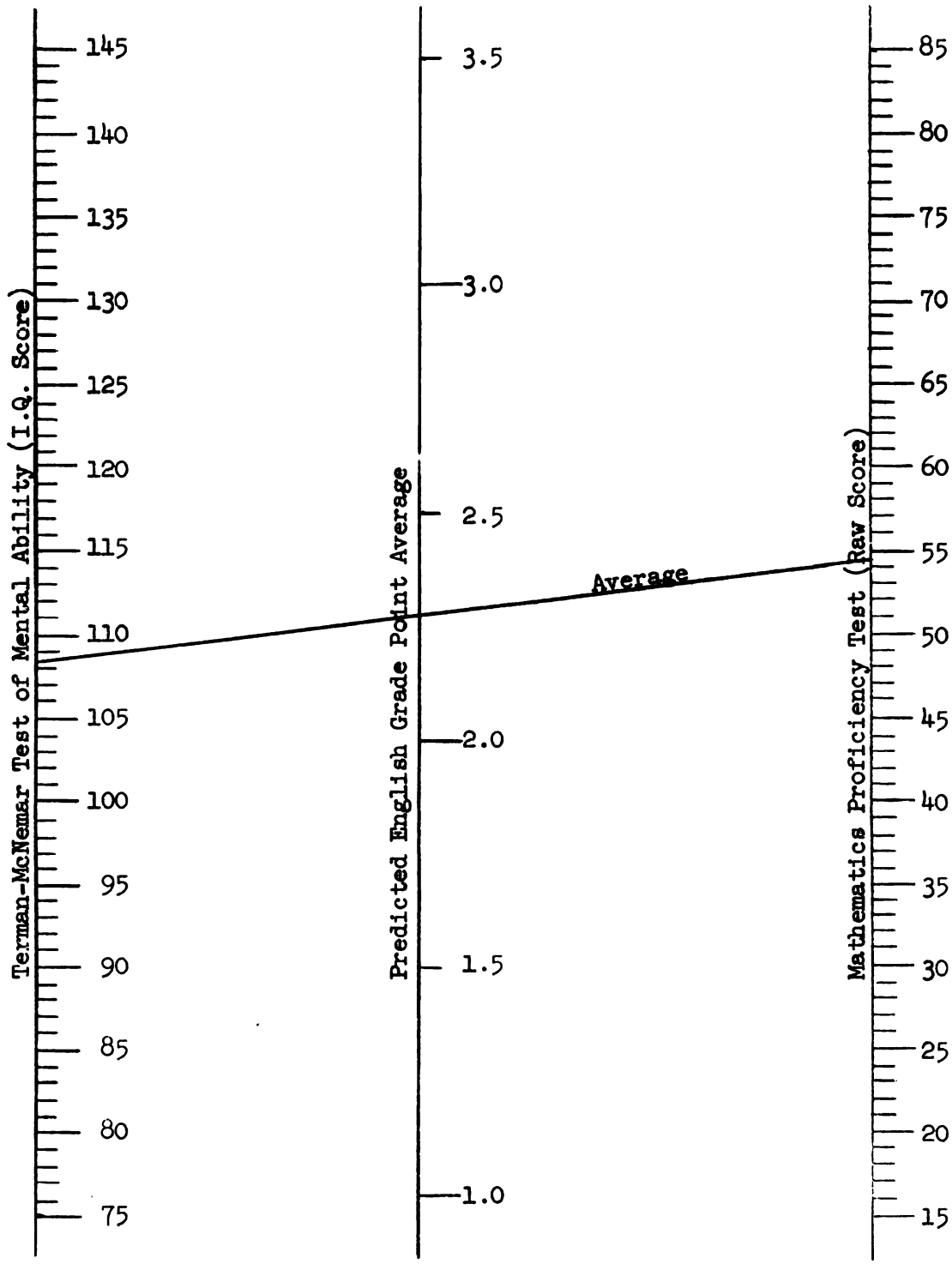

Figure 4

A Nomograph for Predicting Girls English Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

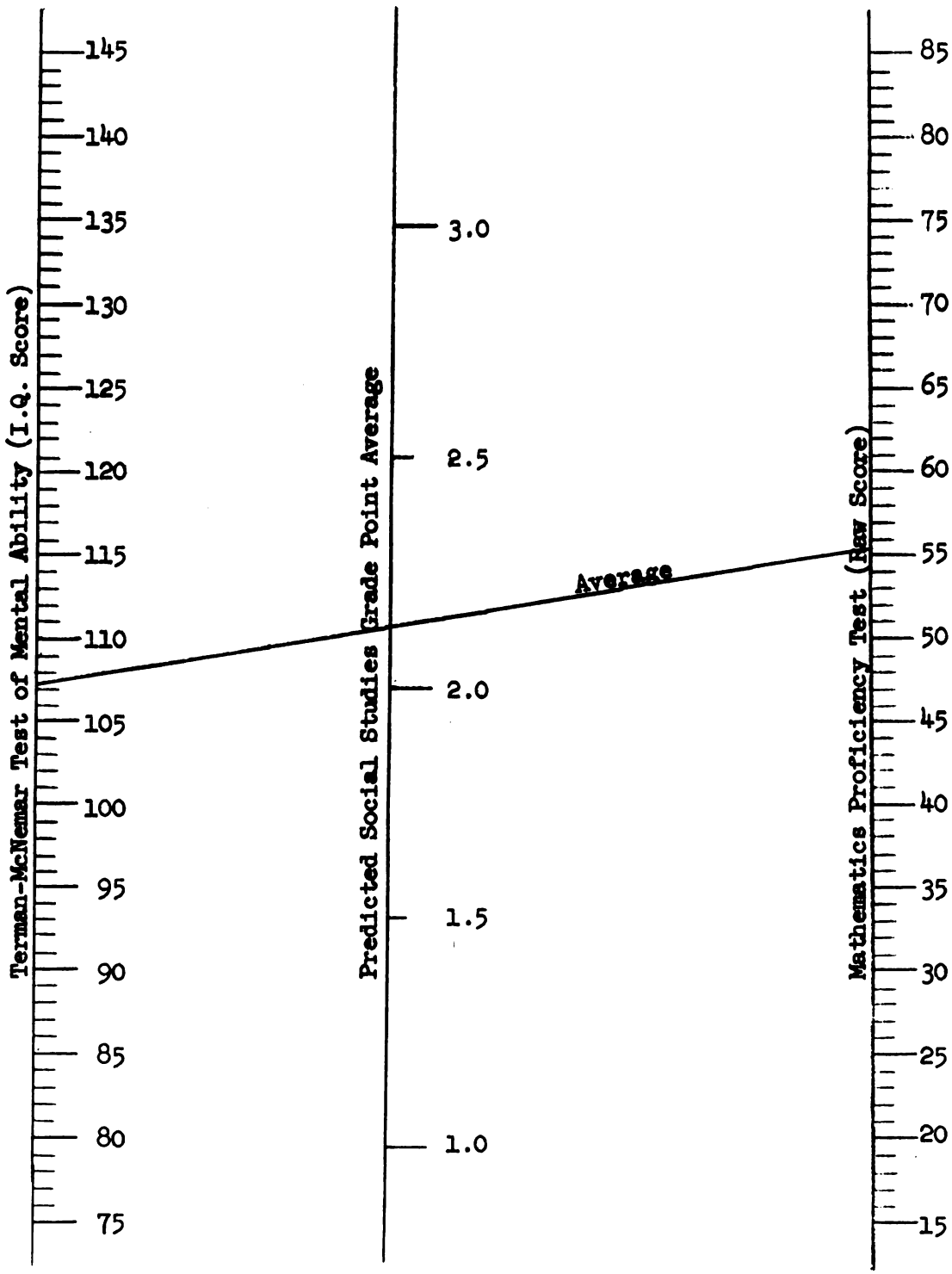

Figure 5

A Nomograph for Predicting Boys Social Studies Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

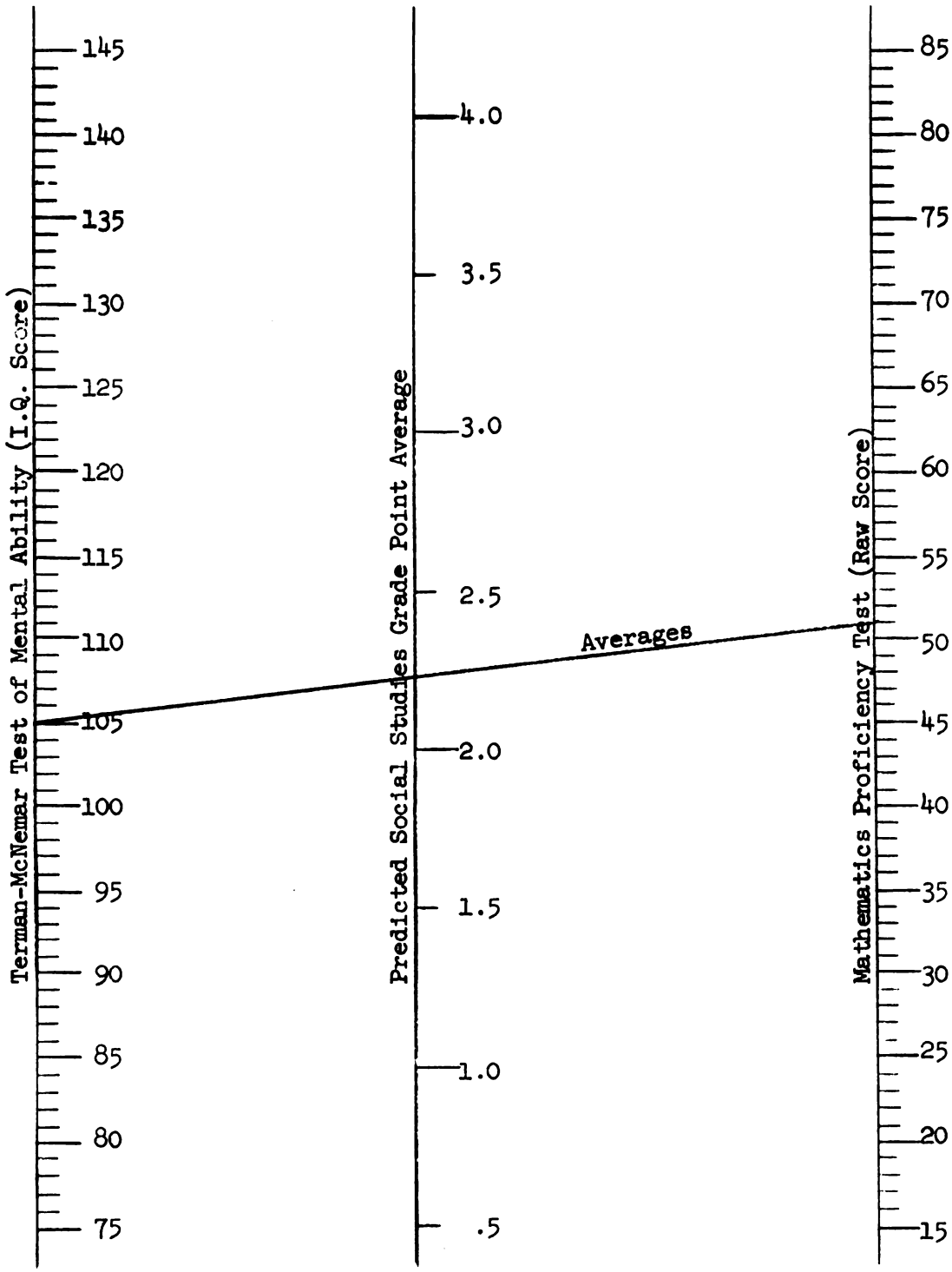

Figure 6

A Nomograph for Predicting Girls Social Studies Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

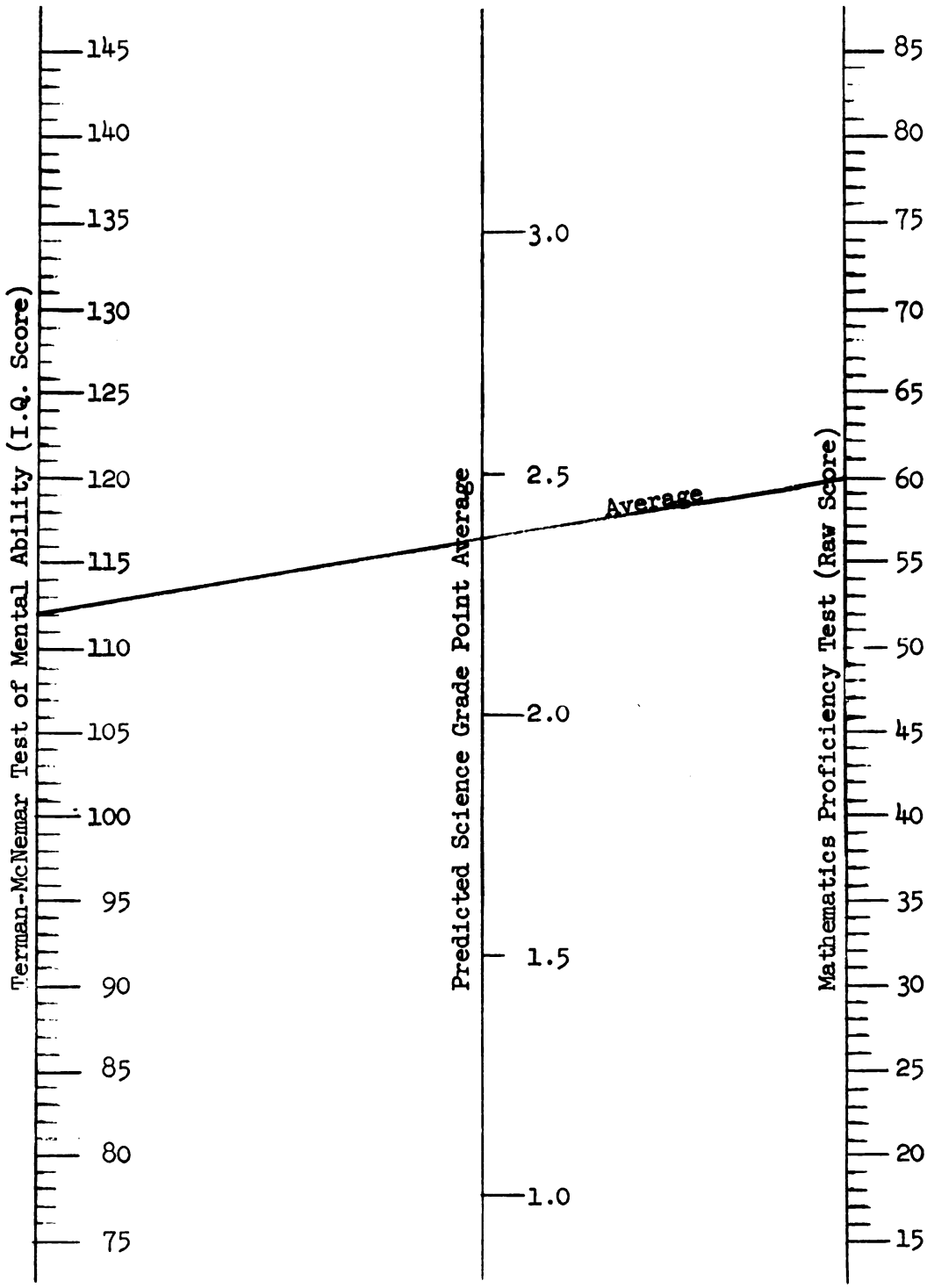

Figure 7

A Nomograph for Predicting Boys Science Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

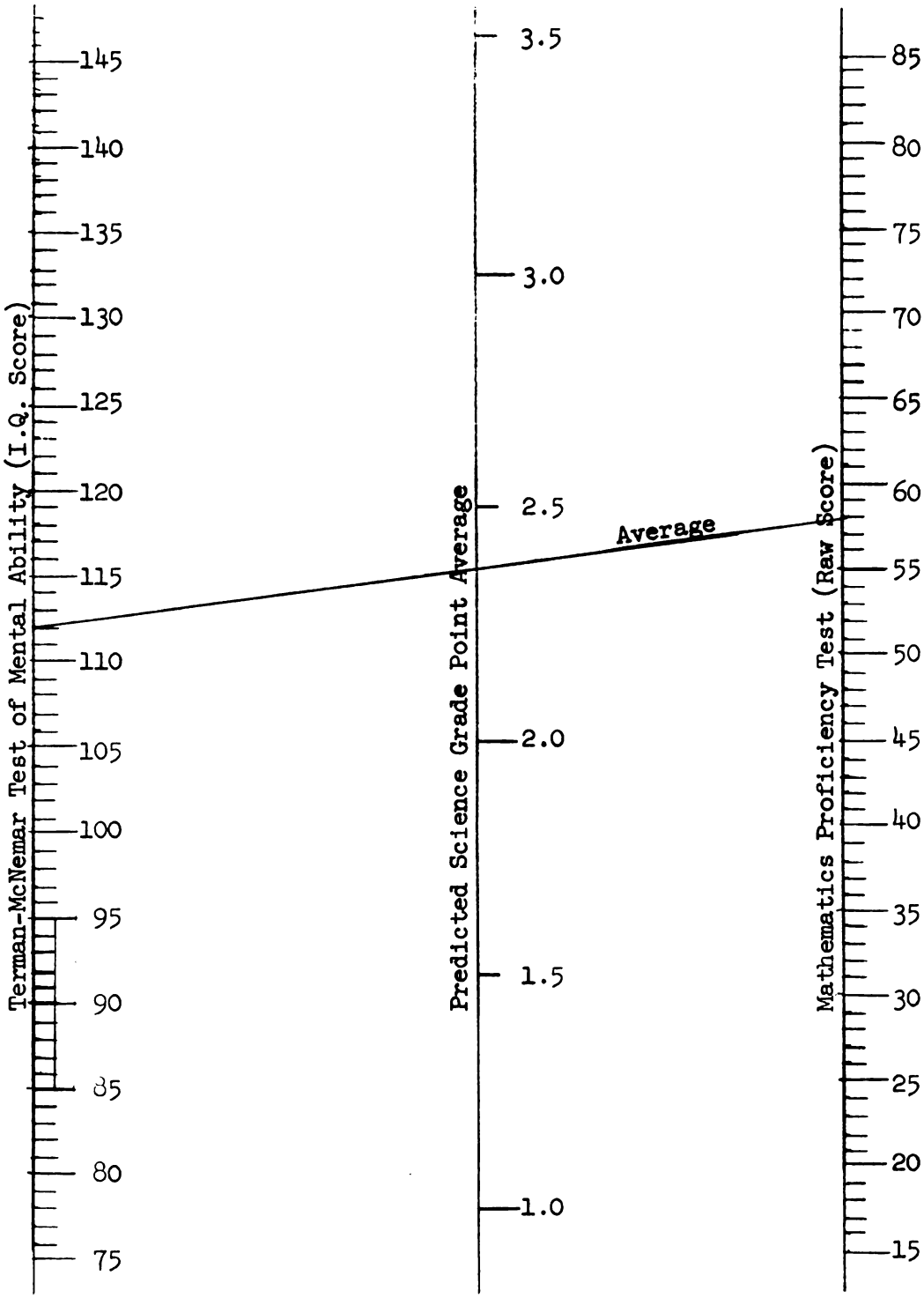

Figure 8

A Nomograph for Predicting Girls Science Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Mathematics Proficiency Test

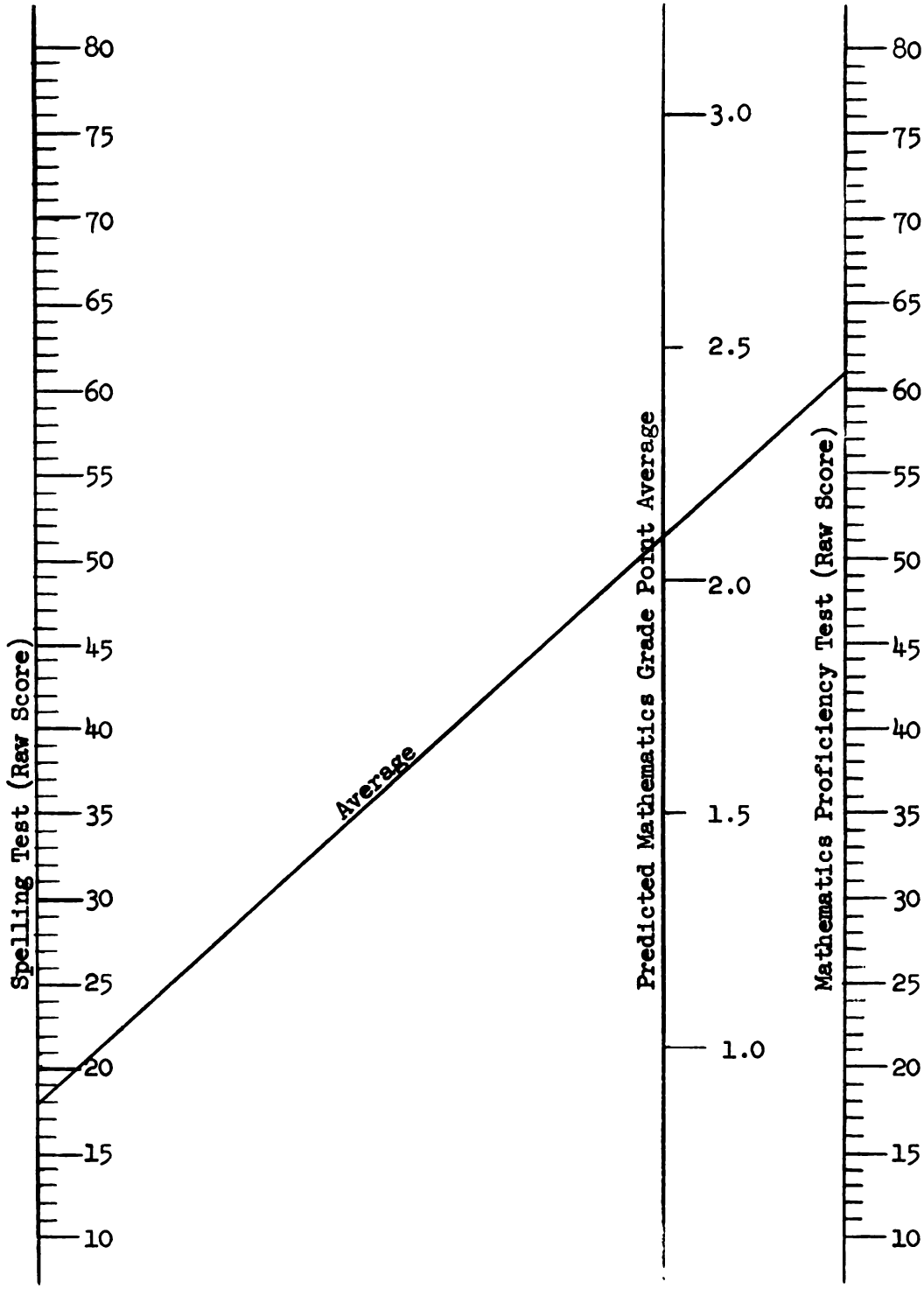

Figure 9

A Nomograph for Predicting Boys Mathematics Grade Point Averages from the Spelling Test and the Mathematics Proficiency Test

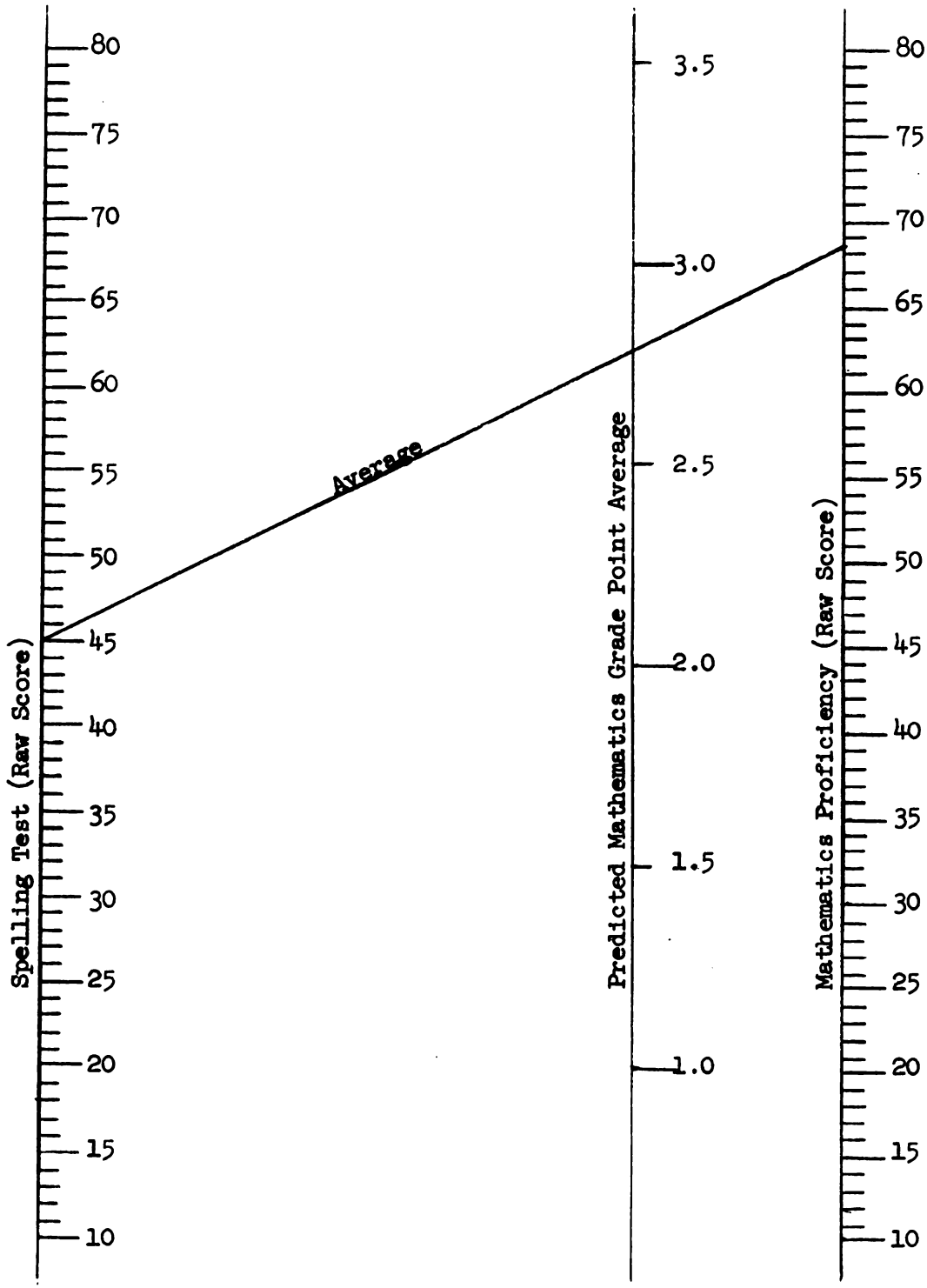

Figure 10

A Nomograph for Predicting Girls Mathematics Grade Point Averages from the Spelling Test and the Mathematics Proficiency Test

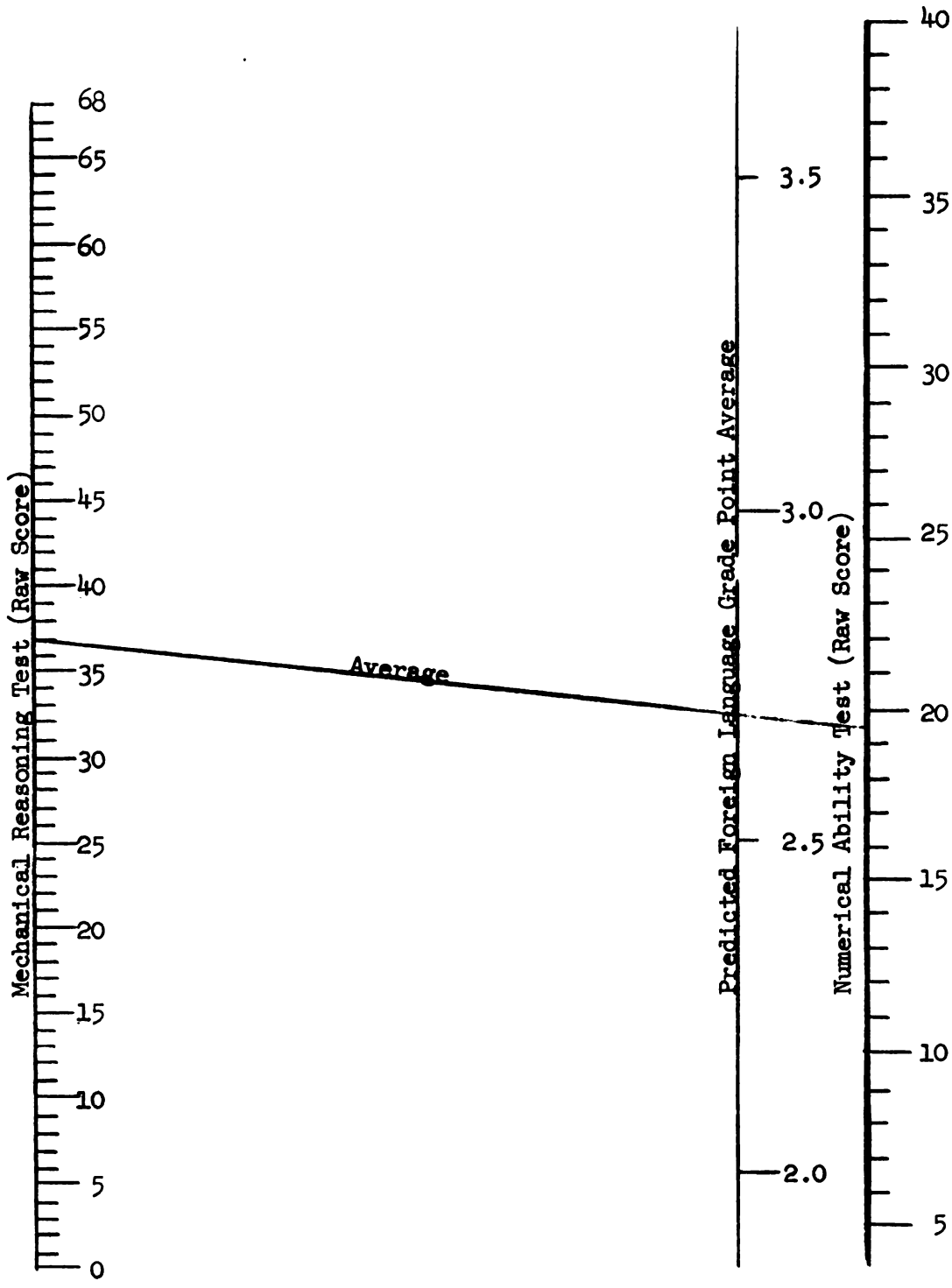

Figure 11

A Nomograph for Predicting Boys Foreign Language Grade Point Averages from the Mechanical Reasoning Test and the Numerical Ability Test

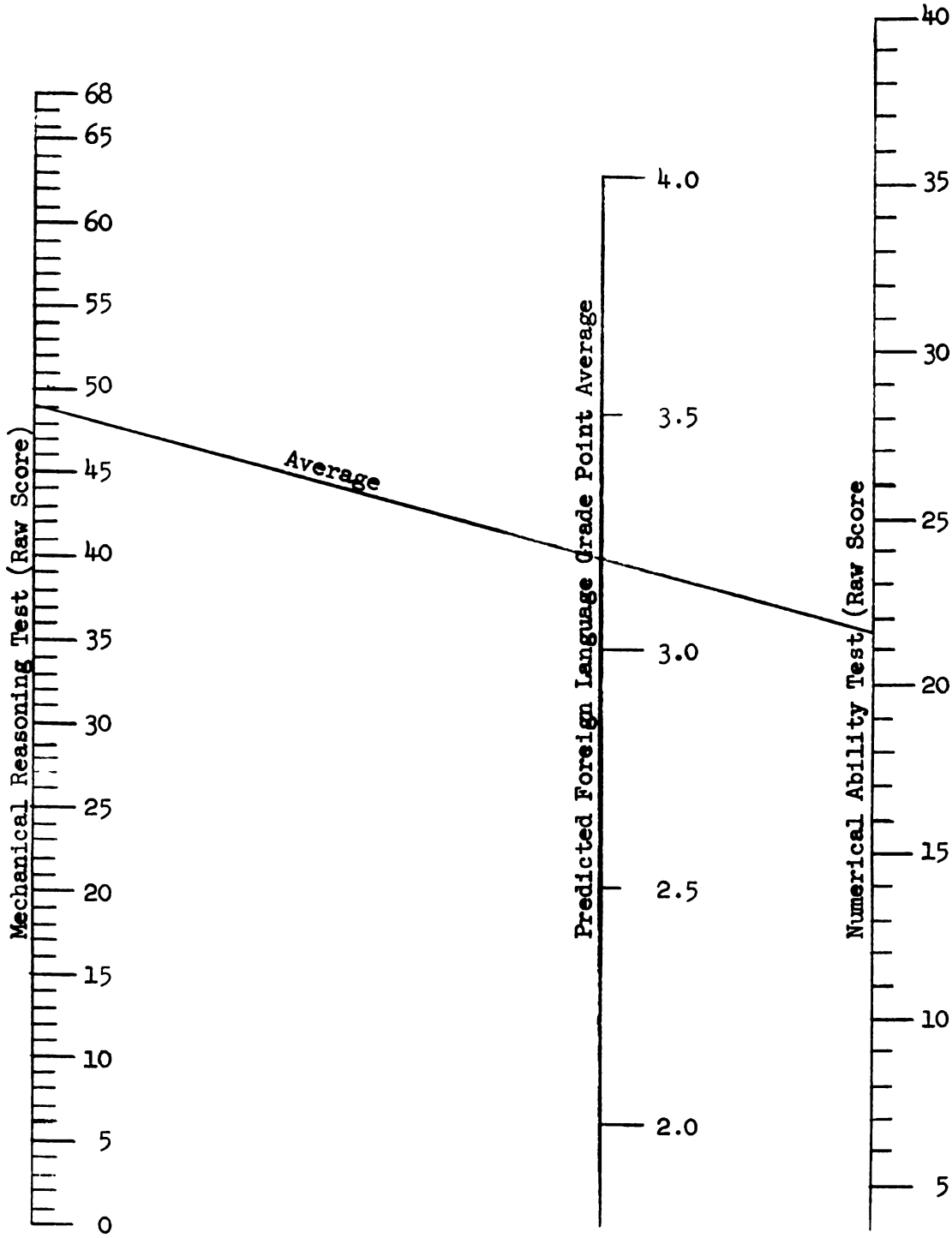

Figure 12

A Nomograph for Predicting Girls Foreign Language Grade Point Averages from the Mechanical Reasoning Test and the Numerical Ability Test

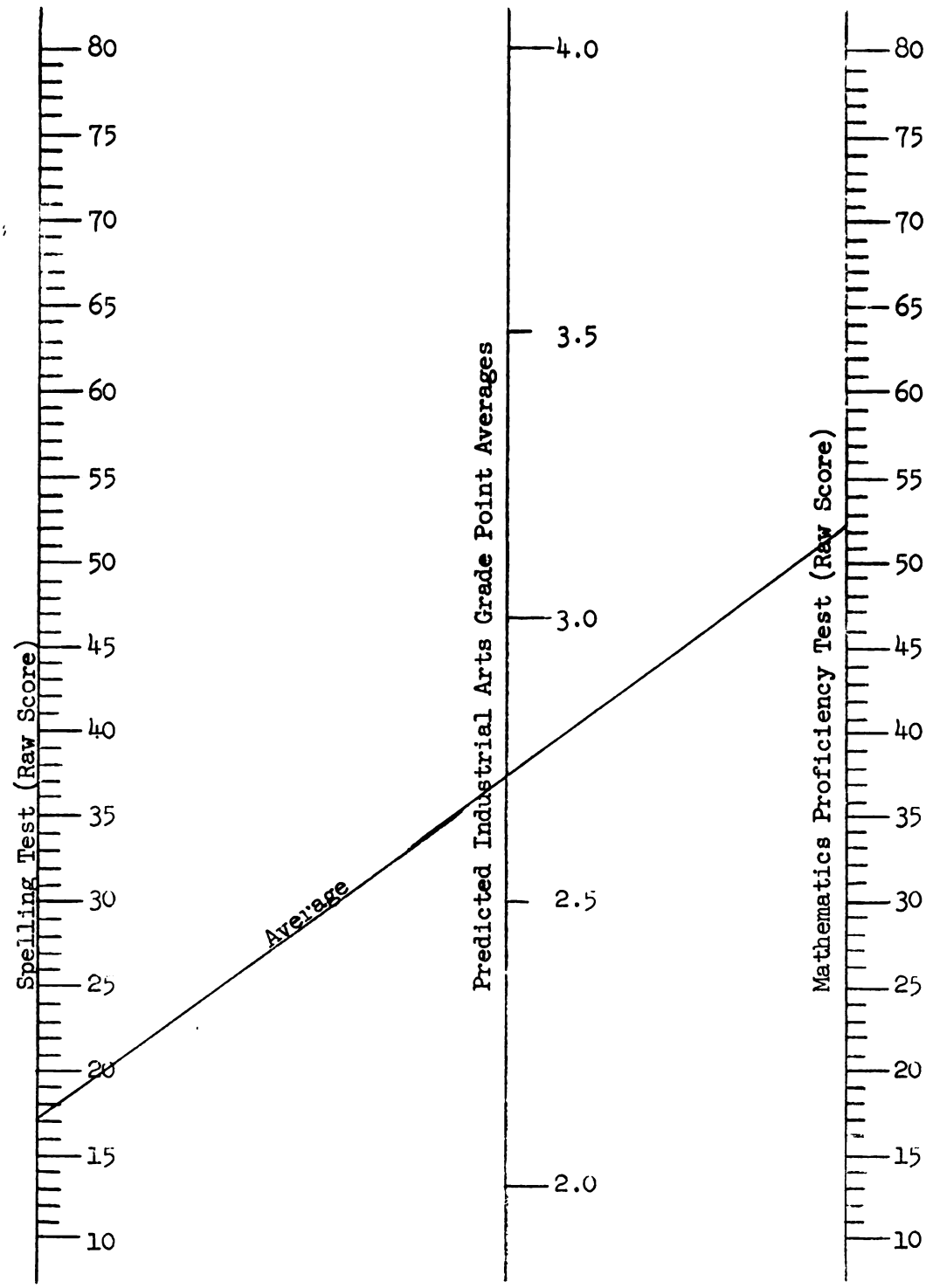

Figure 13

A Nomograph for Predicting Boys Industrial Arts Grade Point Averages from the Spelling and Mathematics Proficiency Test

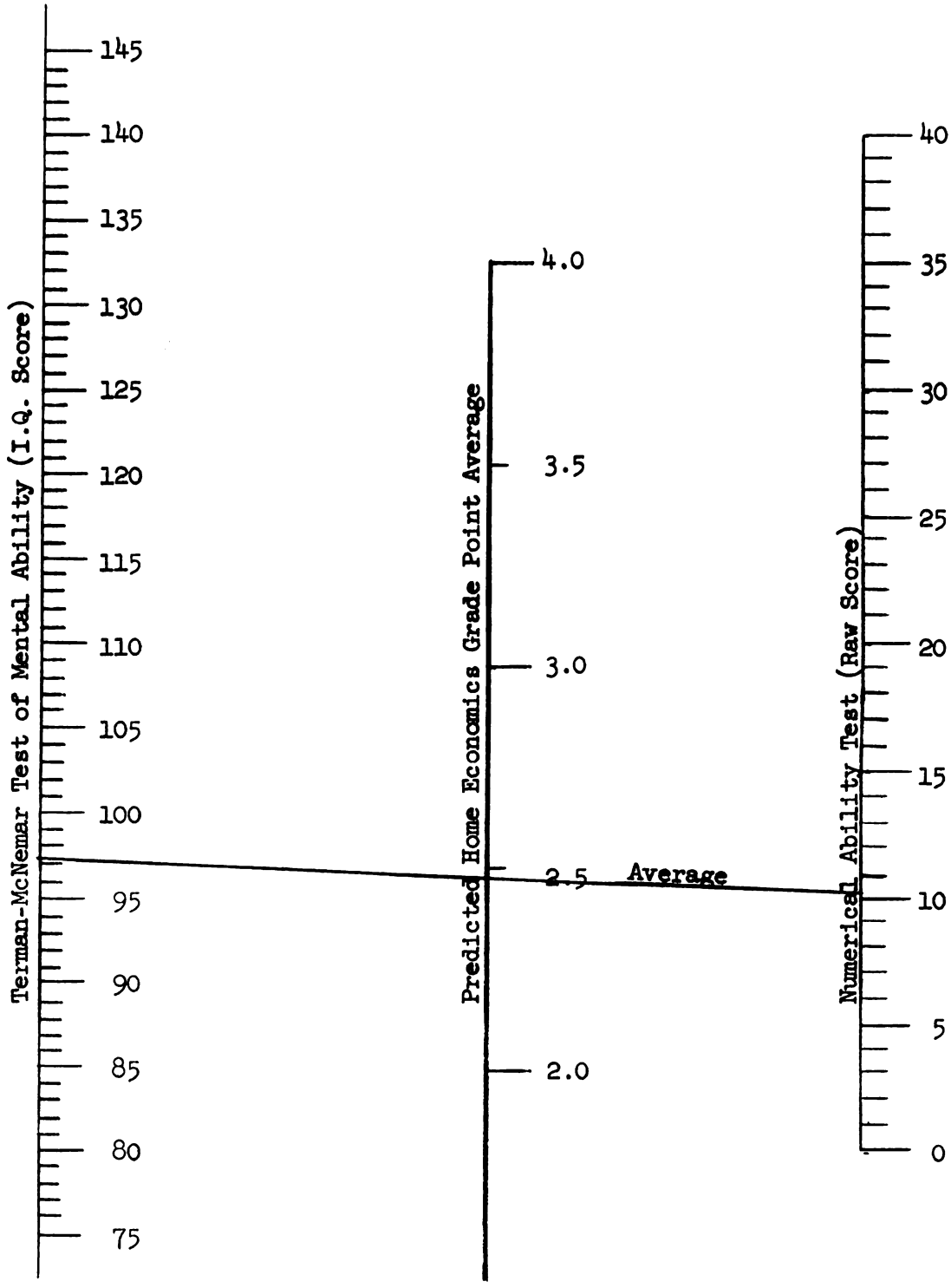

Figure 14

A Nomograph for Predicting Girls Home Economics Grade Point Averages from the Terman-McNemar Test of Mental Ability and the Numerical Ability Tests

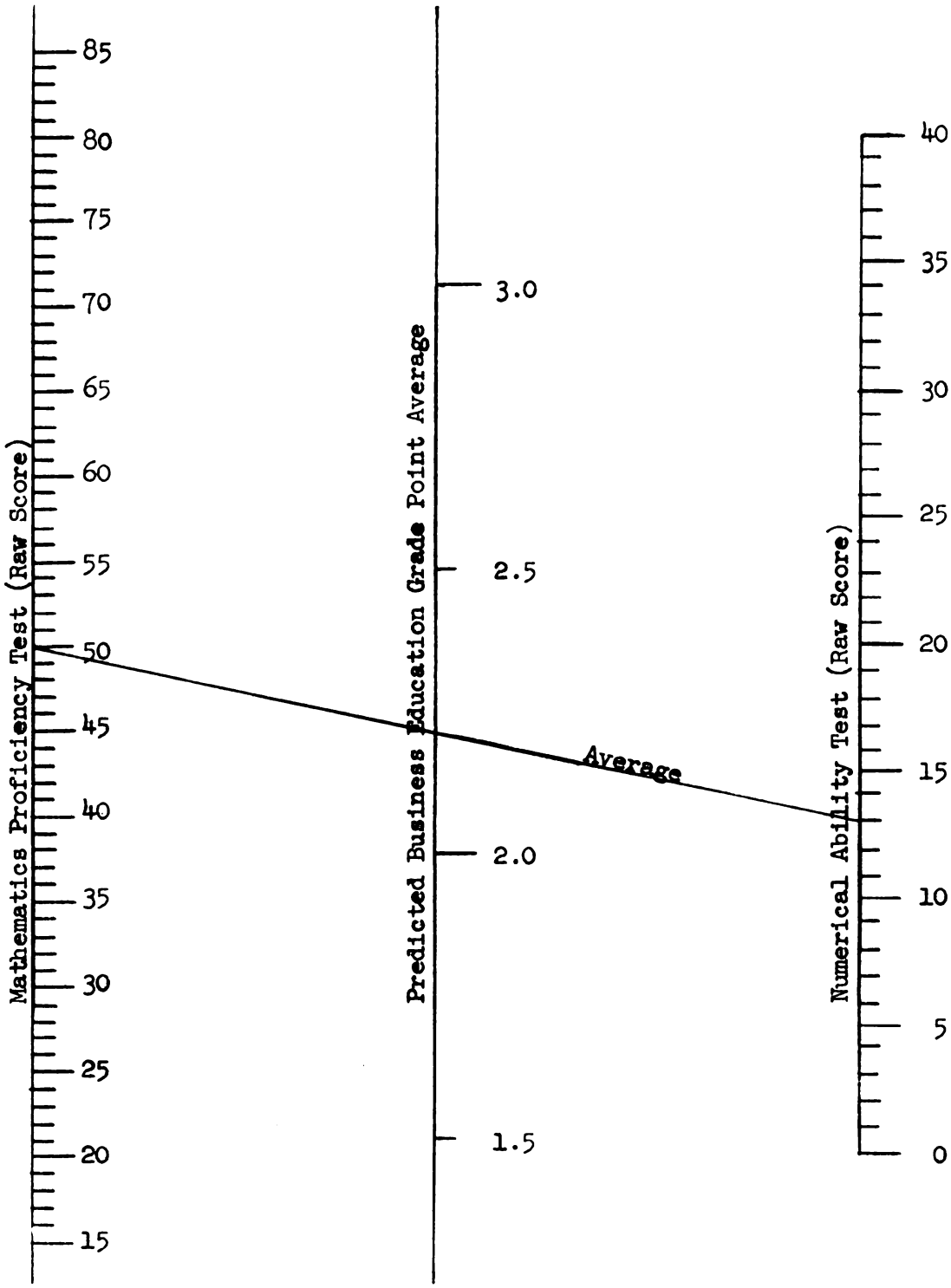

Figure 15

A Nomograph for Predicting Girls Business Education Grade Point Averages from the Mathematics Proficiency and Numerical Ability Tests

APPENDIX D

TABLE 51

REGRESSION EQUATIONS FOR PREDICTING BOYS AND GIRLS GRADE POINT AVERAGES IN EIGHT SUBJECT AREAS

Subject Area	Sex	Equations
English	Boys	$X_{B1} = .0123X_1 + .0144X_2 - .0103X_3 + .0033X_4 + .0015X_5 + .0079X_6 + .0013X_7 + .0097X_8$
	Girls	$X_{G1} = -.0107X_1 + .0235X_2 - .0013X_3 + .0042X_4 + .0046X_5 + .0171X_6 + .0001X_7 + .0101X_8$
Social Studies	Boys	$X_{B1} = -.0056X_1 + .0089X_2 - .0055X_3 + .0047X_4 + .0069X_5 + .0131X_6 + .0037X_7 + .0110X_8$
	Girls	$X_{G1} = .0002X_1 + .0042X_2 + .0006X_3 + .0027X_4 + .0066X_5 + .0137X_6 - .0001X_7 + .0125X_8$
Science	Boys	$X_{B1} = -.0097X_1 + .0013X_2 + .0123X_3 + .0039X_4 + .0072X_5 + .0069X_6 + .0035X_7 + .0151X_8$
	Girls	$X_{G1} = .0004X_1 + .0039X_2 + .0035X_3 + .0031X_4 - .0011X_5 + .0104X_6 + .0032X_7 + .0144X_8$
Mathematics	Boys	$X_{B1} = -.0099X_1 + .0021X_2 + .0030X_3 + .0095X_4 + .0045X_5 + .0093X_6 - .0069X_7 + .0260X_8$
	Girls	$X_{G1} = -.0016X_1 + .0239X_2 + .0148X_3 + .0100X_4 - .0002X_5 + .0040X_6 - .0014X_7 + .0135X_8$
Foreign Language	Boys	$X_{B1} = .0021X_1 + .0516X_2 + .0086X_3 + .0026X_4 - .0100X_5 - .0171X_6 - .0112X_7 + .0194X_8$
	Girls	$X_{G1} = -.0155X_1 + .0428X_2 - .0144X_3 + .0123X_4 + .0019X_5 + .0110X_6 - .0080X_7 + .0144X_8$
Industrial Arts	Boys	$X_{B1} = -.0097X_1 + .0364X_2 + .0053X_3 + .0174X_4 + .0066X_5 + .0115X_6 - .0065X_7 + .0227X_8$
Home Economics	Girls	$X_{G1} = -.0299X_1 + .0509X_2 - .0156X_3 - .0150X_4 + .0125X_5 + .0240X_6 + .0122X_7 - .0062X_8$
Business Education	Girls	$X_{G1} = -.0104X_1 + .0204X_2 + .0030X_3 + .0034X_4 - .0042X_5 + .0041X_6 + .0003X_7 + .0148X_8$