GENERAL AND SPECIFIC PROGNOSIS OF ACADEMIC SUCCESS BASED ON TESTS OF INTELLIGENCE AND PREPARATION.

Dissertation

Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Graduate School of the Ohio State University.

BY

Brian Earle Tomlinson, B.Sc. in Educ., M.A.

Ohio State University

The Ohio State University

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Approved by:

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CHAPTER I

Background Studies in the Prediction of Academic Success of College Freshmen

It has been stated and often repeated that perhaps the intelligence test is one of the most important contributions to the field of education in the past century. This is using the intelligence test in the sense of its modern usage,—an objective, reliable, standardized, more or less valid instrument for measuring intelligence.

The function of an intelligence test is that of determining the mental level of the individual, which after all is merely another way of saying that if we know the mental level of an individual, we know what he should be able to do mentally.

Once intelligence tests were devised, the educator was quick to recognize their possibilities in education.

The uses made by educators of intelligence tests is that of determining the mental level and from that predicting what an individual should be able to do and what he probably will do. That is, then, nothing other than a prognosis. The Army Alpha test devised at the time of the recent war was really the pioneer of all of the standardized group intelligence tests. Its possibilities were immediately recognized, and the colleges and universities soon
began to make extensive use of the Alpha as a predictive agent. Numerous other group intelligence tests have been devised since the Alpha, but almost all of them still bear some resemblance to the parent test.

Along with interest in tests statistical interests and techniques for prediction have also developed. Many studies have been made merely for the statistical experience or pleasure that accompanied the study.

Likewise, immediately following this war, the increase in college enrollment was tremendous. Many individuals who could not profit by the college curriculum as it existed at that time—or now, for that matter, for it has not changed greatly in the past ten or twelve years—were enrolling in college.

A search was made for some sort of discriminating agent which would differentiate between the individuals who would probably succeed in college and those who would fail. Since the Army Alpha had been successful in differentiating officers' material from the privates, it was employed in the colleges and universities to differentiate between potential failures and successes in college.

Before the advent of the intelligence test the college entrance examination was about the only restrictive agent used with respect to college entrance.

As new and somewhat better tests were devised they displaced the Army Alpha in a number of the colleges and
universities. The tests that have been most widely used in deciding college entrance and prognosing success in college are the Army Alpha, Thorndike, Thurstone, Brown University, and Ohio State University. There are in addition numerous local and less well known tests.

A survey of the literature reveals that the intelligence test is not only the most used agency for predicting college success, but in the words of Wood and McPhail, "It is perhaps the best single predictive agency."

A few characteristic researches that have been made, together with their findings, will be reviewed.

The Army Alpha test has been used in numerous colleges with varying degrees of success as a predictive agent. Jordan at the University of Arkansas and Terman at Stanford University produced studies showing the correlation between the Army Alpha test and college grades to range from .28 to .65. These studies were made in 1921-22, and although the lower correlation found is somewhat below the average of recent findings, the upper range (.65) is still quite high.

Also in 1922 Colvin and McPhail used the Alpha, Brown University, and Thorndike examinations as predictive agents and found the Alpha scores to correlate to the extent of .44-.46 with academic grades. The correlations between the Thorndike examination and academic grades were
from .37 to .53. Brown University examination results and grades correlated from .34 to .60. A combination of the last two tests did not significantly raise the correlation.

In fairly close agreement with the findings with respect to the Alpha test cited above are found Stow's work at Dartmouth, Decarp's at Pennsylvania State College, and Stoddard's at Iowa. Bridges' correlations were lower at Ohio State: .15 to .38.

The Brown University results mentioned above are reported as correlating between .34 to .60 with academic grades. The average correlation obtained between this test and grades is about .40.

The Thurstone Intelligence Test is reported to have the following correlation coefficients with academic work at various colleges: .37 at Carnegie Institute; .31 at Cornell; .20 to .26 at Gaucher; .48 at Illinois; .33 at Vassar. These correlations are on the whole lower than those of the Alpha or Brown University test.

The Thorndike Intelligence Test is widely used, and the following correlations have been reported: .37 to .53 at Brown University; .46 at California; .41 at Chicago; .59 to .67 at Columbia; 46 to 67 at Gaucher. These correlations are significantly and consistently higher than others thus far reported.

The Ohio State University Psychological Test is
used widely throughout Ohio, and various correlations are reported. They range from about .35 to .65 depending upon the groups selected. The validity of this examination is probably above .50.

Other investigations than those in which the only measure was the intelligence test are the College Entrance Examination Board's test which is reported in the proceedings of the Board (1921-25) to have a validity of .40-.50, and were all subjects examined allowed to enroll in college, it would probably have a validity of .60-.70.

Combinations of College Entrance Board Examination, intelligence test (Thorndike), and high-school record correlated with scholastic success as high as .66. Wood concludes on the basis of his findings that the intelligence test is perhaps the best single predictive agent.

Stoddard has found the battery of subject-matter (Iowa Placement Tests) examinations to have a validity of .65-.75 for predicting grades.

To summarize these studies:

1. The most frequent agent used for predicting college success is the group intelligence test.

2. The first of these tests was the Army Alpha, but numerous other tests have been devised and used.

3. The correlation coefficients obtained between test scores and academic success vary from .13, or nearly
zero, to .65 or .75. The average is between .40 and .50.

4. Combinations of intelligence tests with other tests raise the correlation still higher.

5. Although the correlations between test scores and success are not high, they are nevertheless significant. They measure only a small fraction of all of the factors which enter into scholastic success, and hence it is surprising that they predict as accurately as they do.

6. The ideal situation is of course to measure all factors entering into success. Correlation coefficients will then approach 1.

7. Non-test factors often enter markedly into academic success.

8. The intelligence test is probably the best single predictive agent, but it should be supplemented with other materials--subject-matter tests, etc.
CHAPTER II

The Present Problem

In the previous chapter a very considerable amount of material was reviewed that concerned the prediction of academic success at the college level--especially the success of the college freshman. The only criterion of success that was used in the previously cited studies is that of course marks or point-hour ratios. The same criterion of success will be accepted in the present study.

No doubt the educational philosopher, as well as many other educators, could argue at length (and with good foundation) that the part of college success that is measured by tests and indicated by point-hour ratios is insignificant indeed when compared with such values as leadership, creative thought, etc.; but these other values, desirable as they are (and to say that they are not valuable would be absurd), do not readily lend themselves to objective treatment; they are more often treated subjectively and evaluated on the grounds of personal opinion rather than subjected to scientific analyses. We will, then, consider success only in terms of the marks received.

It is the purpose of this study, as it has been the purpose of previously cited studies, to make the best
possible prediction of academic success of first-quarter freshmen from not only intelligence-test scores but also from the scores obtained on subject-matter tests that pertain especially to the elementary school level. This study will support some of the findings of researches previously mentioned, while it will contradict others.

A point worth considering is that in an overwhelming majority of the studies the most frequent predictive agent used was the group intelligence test. The Army Alpha test was of course, as was previously mentioned, the pioneer of these. The correlation between the Army Alpha test scores and college grades ranges from .35 to .55 with an average correlation of near .45. The Army Alpha test, or parts of, it has been incorporated in practically all group intelligence tests which have been devised since its origin. The group intelligence test is usually considered to be the best single predictive agent of general scholarship. In 1923 Wood (Measurement in Higher Education, p. 91) wrote, "The intelligence test is not only as good a criterion for admission to college as any other single criterion used, but it is more efficient and less expensive."

Wood meant specifically the Thorndike examination, with which he was working at that time. He advises, however, that the intelligence test be combined with other criteria. Between the Thorndike examination and scholarship he found a
correlation of .55, and when the intelligence-test scores were combined first with the Regents examination score, then with both the Regents examination scores and high-school marks, he obtained multiple correlations of .6573 and .6623 respectively. Both his zero order correlations and his multiples are representative of other researches, except perhaps his correlations run somewhat higher than the average. Furthermore he was, as is the case in most of the other researches, attempting to predict only general scholarship.

This study will differ, then, from previous studies in two ways. First, it will attempt a general prognosis of scholarship in each of two colleges. These prognoses will be based on intelligence-test scores and also on scores obtained from reading, mathematics, language, and history tests. Secondly, the present study will attempt a prognosis for each of several subjects; the subjects are languages (French, German, Spanish, and Latin), mathematics, history, and chemistry.

Zero order coefficients as well as multiple correlations will be employed for the general prognoses, while simple, or zero order, correlations between subject matter tests and course marks will be the technique employed for the latter predictions.
Summary

1. In a majority of attempts to predict general scholarship the group intelligence test was the only predictive agent used.

2. Occasionally group intelligence test scores have been combined with other criteria for this prediction.

3. The average correlation obtained between intelligence-test scores and scholarship marks is near .45, although several studies report higher correlations.

4. This study will attempt the prognosis of both general scholarship and marks received in specific courses; the courses are language, history, mathematics, and chemistry.

5. The techniques used in this study will be both zero order and multiple correlation coefficients.
CHAPTER III
Materials and Methods

I. The Materials

A. The Tests.—The tests used in this study were six in number. They were the Ohio State University Psychological Test (which is quite often referred to as the "University Intelligence Test"), the Reading Test (which is Test V of the intelligence test mentioned above), and four subject-matter tests (usually referred to as the Freshman Week Tests). The specific tests used were reading, mathematics, language, and history. An English test was also given, during the freshman week period, but the test was so unsatisfactory due to its low reliability and low validity that the results obtained from it were excluded from this study. Each of the tests used will be described at some length.

1. The Ohio State University Psychological Test is, as was stated above, often referred to as the University Intelligence Test, but due to the absence of a general acceptance of any satisfactory or universal definition or concept of intelligence, the test often calls forth serious and heated discussions as to whether it is really an intelligence test or not. An intelligence test is presumably a test that will measure intelligence, and, depending
upon the definition accepted, one test might prove to be just as good a test of intelligence as another. To illustrate, one might conceive of intelligence as an ability to remember dates, and in this case a test that would measure this ability would, by definition, be a good test of intelligence.

It is outside the scope of this study to discuss intelligence together with theories and assumptions. To return to the Ohio State University Psychological Test, however, it may be said that Dr. H. A. Toops, who has done the major portion of the work in originating, developing, and improving the test, lays no claims to its being a test of intelligence; rather, he would say that he characterizes it as being a test of "general academic prognosis." Insofar as intelligence enters into scholastic success and is measured by this examination, it is then an intelligence test. But further, insofar as factors other than intelligence that have to do with academic success are measured by this examination it is a test of academic prognosis.

It is perhaps not worth while to quibble over terms or names for the test; suffice it to say then that the primary purpose of the test is that of predicting academic success as indicated by grades or marks. This test will be referred to in this study as the Ohio State University Test or as the intelligence test.
The test is issued in several forms; usually two forms are devised each year. The purpose of the frequent issues of the tests is to avoid the possibility of familiarity with the test; then too, poorer items are eliminated and better items are being added to each succeeding form, thus making the test a more valid criterion for predicting scholarship.

The test consists of five parts or sub-tests. They are mathematical problems, vocabulary, analogies, number combinations, and reading.

The general directions cover the first page. In the general directions, the purpose of the test is explained, and the subject is informed that the test is designed to ascertain how quickly and accurately he can think; he is urged to do his best and not skip around. He is also informed that a rigid time limit is set for each test.

The next two pages are devoted to samples and practice problems. A sample and a practice problem of each type that is used in the entire test appear on these practice or pre-tests, and are designed to act as what Paterson calls "shock absorbers" for the test proper.

Two pages of arithmetic problems consisting of forty problems with a time limit of twenty minutes make up test 1. The same samples that appeared in the practice tests appear again at the beginning of the test. This procedure
is true of the separate tests of the entire examination.

The samples are as follows:

How many men are five men and ten men?  Answer 15  A

If you walk four miles an hour for three hours, how many miles have you walked?  12  B

The vocabulary or same-and-opposites test consists of eighty words, the same or opposites of which are to be identified among the words suggested. The time limit for this test is nine minutes. The samples for the vocabulary test are:

Good is the opposite of  1. excellent 2. cheerful 3. bad
4. wrong 5. true  3  A

Little is the same as 1. coarse 2. small
3. prodigious 4. feeble 5. immense  2  B

Return is the opposite of 1. advance 2. succeed
3. revolve 4. go 5. send  4  C

The number of the correct word is to be written in the proper space. This mode of response, i.e. the correct response placed in the place indicated was the case also in the arithmetic section and will be true for the succeeding sections.

Test 3 or the analogies test is somewhat longer than either of the preceding tests; there are four pages, each containing thirty test items, or a total of one hundred twenty items. The time limit for test 3 is eighteen minutes. The samples for this test are:
Answer
2 A

push pushed run 1.running 2.runs 3.runner
4.ran 5.runned

4.Jones 5.Jons

Test number 4 of the Ohio State University Test is
composed of fifty groups of number combinations, or "digit
gymnastics", as you prefer. The directions are to find the
rule by which the combinations are made up and to copy in
the spaces provided the number or numbers that spoil the
series. The samples for test 4 are as follows:

2 4 6 8 9 10 9 A
4 6 7 8 10 12 7 B
3 4 5 6 5 7 5 C
18 16 14 10 6 2 16 D

The time allowance for this test is six minutes.

The fifth and last test of the series is by far
the longest of any of the group of tests. It consists of
eleven paragraphs of readings, and following each para-
graph a series of questions are asked that have to do with
the content of the paragraph. The number of questions
asked about each paragraph varies from five to fifteen.

The directions for the entire test 5 are to read
the paragraph and answer the questions asked beneath it.
The paragraphs may be reread as often as is necessary. They are to be read in order and answered according to the specific directions; i.e. if the question asks for one word found in the paragraph, one word only should be used; if the words are asked for, two words and two only should be given; if a phrase of exactly four words is demanded, then the question should be answered in a phrase of but four words.

Paragraphs 1-6 inclusive, 8, and 10 are to be answered in the manner described above. For paragraphs 7, 9, and 11, however, the subject is instructed to write in the proper space (the line at the right) the letter C after each thought that is contained in or can be inferred from the paragraph, and the letter N after each statement that is not contained in and cannot be inferred from the paragraph.

The test consists, as was stated above, of eleven paragraphs which cover seven pages. The time limit for this section is thirty-six minutes as opposed to the forty-eight minutes that is given to the first four tests combined. The total number of points allotted to this test is one hundred five. The maximum number of points for the first four tests combined is two hundred ninety.

The entire test is scored by the all-or-none procedure, and one point is given for each correct response.
No credit is given for a partially correct response. The total number of points in the entire test is three hundred ninety-five.

To avoid confusion later it should be pointed out here that the Ohio State University test, including the reading section, is counted as one test, and that the reading test (number 5) is also scored separately and used as a test. There was also a Freshman Week reading test administered. To differentiate between the two reading tests they will be designated as the Ohio State University Reading Test and the Freshman Week Reading Test.

The eleven paragraphs of test number 5 referred to above represent a sampling of a variety of subjects varying in difficulty from easy to hard, and in subject matter ranging through topics of war, education, geology, agriculture, architecture, literature, geography, history, government, and law.

Form No. 13 of the Ohio State University Psychological Test is the specific form of the test that has been described above. All forms of the test, of which there are eighteen at present, do not conform to this description. For example, some of the earlier forms were not so long; neither were they as varied as the form just described. Likewise succeeding forms will differ somewhat from Form 13. In spite of these differences a very marked
similarity exists between all the forms; in fact identical
directions are given for several forms of the same test.

Form 13 was chosen for this illustration specifi-
cally because it was the form that was administered to all
students entering the College of Education. It is neces-
sary, for the purpose of meeting a legal requirement, to
give all College of Education students the same form of
the test so they can be compared on the basis of the same
test rather than on similar tests. All College of Educa-
tion students are required to score at the fifteenth per-
centile or above on the test to remain in the college.
Percentiles and other scoring and interpolation techniques
will be discussed more fully in Part II of this chapter
under the head of scoring of the tests and interpretation
of the results.

The theory underlying the exclusion from the Col-
lege of Education of the students who score in the lowest
fifteen percentiles is, of course, that the students who
score lowest on the test do not exhibit as great a degree
of professional promise as do students who show a higher de-
gree of preparation as indicated by their scoring higher on
this test. It is outside the scope of this study to dis-
cuss the relationship, if any, existing between test scores
and teaching success; hence no attempt will be made either
to justify or condemn the fifteenth-percentile requirement
in the college. The subject of relation of grades to teaching success has been the basis for several researches, and the conclusions reached with respect to the amount of relationship existing between these two factors are very conflicting. Edgerton, however, has very conclusively pointed out that the chances of an individual's graduating, if he scores in the lowest percentiles, are rather poor; however, he failed to find any very satisfactory predictive agent for persistence. Persistence was measured only by the number of consecutive quarters the individual remained in school.

The following table will serve to summarize the information concerning the Ohio State University Test:

<table>
<thead>
<tr>
<th>Number of Test</th>
<th>Subject</th>
<th>Number</th>
<th>Time Allowed</th>
<th>Points</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>General directions</td>
<td>1</td>
<td>7</td>
<td>*17</td>
</tr>
<tr>
<td></td>
<td>Practice tests</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Arithmetic</td>
<td>2</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Vocabulary</td>
<td>2</td>
<td>9</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>Analogies</td>
<td>4</td>
<td>18</td>
<td>120</td>
</tr>
<tr>
<td>5</td>
<td>Number combinations</td>
<td>2</td>
<td>7</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Reading</td>
<td>7</td>
<td>36</td>
<td>105</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>20</td>
<td>102</td>
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</tr>
</tbody>
</table>

*The points in the practice tests do not count in the total number of points for the entire test.

It was stated in the preceding chapter that the Army Alpha test is the pioneer of all group intelligence tests. Likewise it is to the point to again mention that Wood considers the group intelligence test to be the most valid of any of the criteria for predicting academic
success. The Ohio State University Test resembles both the Army Alpha and the Thorndike examination. The latter was patterned after the Army Alpha. The Ohio State University Test, then, should and does represent an improvement over both the other tests.

2. The Ohio State University Reading Test has already been described as a part of the entire examination; it will not be necessary to go into any further detailed discussion of it at this time.

3. The Freshman Week Mathematics Test was devised for the purpose of predicting academic success of freshmen in subjects (especially chemistry, physics, and mathematics) which require certain mathematical skills, concepts, and vocabulary.

Under the direction of Dr. L. C. Pressey, several textbooks in physics, chemistry, and mathematics were analyzed and all the problems were solved. These problems were then analyzed to ascertain the skills needed for solving problems in science textbooks. In addition to the analyses mentioned above, which were made for the purpose of determining the necessary skills in problem solving, numerous arithmetics, algebras, and geometries that are used as textbooks in the public schools had previously been analyzed to ascertain the technical vocabularies in mathematics and the necessary concepts used in mathematics.
These basic skills, concepts, and technical vocabularies were then incorporated into the Freshman Week Mathematics Test.

This test was composed of two parts, as follows:

Part 1. Problems (50)
   A. Arithmetic (12)
   B. Algebra (38)

Part 2. Necessary Concepts (37)
   A. Units of measure (13)
   B. Understanding of equations (9)
   C. Technical vocabulary (15)

A further description of each test and section is necessary for an understanding of the test.

As stated above, Part 1 consisted of fifty problems. Twelve of these problems were arithmetical, while the other thirty-eight were algebraic.

The twelve arithmetic problems consisted of the following types of problems:

1. Two problems in addition of common fractions.
2. Two problems in division of common fractions and mixed numbers.
3. Two problems in division of decimals.
4. Four problems in percentage.
5. Two problems requiring that certain relationships be expressed as (a) common fractions, (b) per cents, and (c) decimals.
Section 2, or the algebra section of Part 1, consists of thirty-eight algebraic problems as follows:

1. Addition: two problems each of addition of monomials and of algebraic fractions.

2. Subtraction: two problems involving the subtraction of monomials.

3. Multiplication: the problems in multiplication consisted of two problems dealing only with the multiplication of monomials and of four problems involving skills in the multiplication of fractions. In two of the last-named multiplications only monomial numerators and denominators were involved, while in the other two problems binomials were in either the numerator or the denominator or both.

4. Division: four problems involving the division of algebraic fractions. Two of the fractions were monomials, while the other two were binomials.

5. Simplification of terms: Four problems were concerned with the simplification of terms. The simplification consisted of removal of parentheses, collecting of terms, etc.

6. Equations: Eight problems in equations (find the value of \( x \) or \( y \)) came next in the test. Four of these problems had to do with whole numbers only, while a like number were made up of fractions.
7. Substitution: Like the equation problems
the substitution problems (substitution of known values
in formulae) involved both integers and fractions. There
were, however, only two problems dealing with each of the
above-named concepts as contrasted with the four each in
the equations.

8. Proportions: The problems in proportions con-
sisted of two problems which were to be written to show
different values; e.g. rewriting the equation $a/b = c/d$
to show the value of $a$.

In solving the tests, in each instance where two
like concepts appear, both had to be correct for any credit.
One right and the other wrong merited no credit.

Part 2: Necessary Concepts.--It should be explained
that the textbook analyses mentioned heretofore as well
as various other textbook analyses formed the basic mater-
ials for the second part of this test.

Part 2, as stated above, consists of three sections.
These three sections will need some explanation.

Section 1: Units of measure.--This section was
made up of eleven questions dealing with weights and mea-
sures in both the English and the metric systems. The
weights involved only a knowledge of avoirdupois weight,
while the measures were linear, square, and cubic in both
systems mentioned above.
In addition to the eleven questions relating to units of measure just mentioned, there were also in this section two questions dealing with the properties of right triangles; e.g. The hypotenuse of a right angled triangle is equal to what? Which angle of the right angled triangle given is equal to approximately 30 degrees?

Section 2: Understanding of equations.—Six problems, the solution of which would involve an understanding of equations made up Section 2 of Part 2 of the mathematics test.

An idea concerning the specific nature of the equation problems can be had from the examples below:

Rewrite the equations:

1. So that if you add 4 to the left side of the equation, it will still be true. \( x^2 + 4x = 12 \)

2. So that the right side of the equation will be just 24. \( x + 4 = 31 \).

3. If you reduce the left side of the equation by 4, so its value will be the same. \( 4a - 8y + 4b = 25 \)

4. So that if you know the value of the equation and square the left side, it will still be true. \( 3(a + b) = 5(c + d) \)

5. If you multiply the left side of the equation by 4, so it will still be true. \( 5x - 3/4 = m + 2n \)

6. So as to solve for the value of \( x \) by extracting the square root of \( x^2 \). \( x^2 = (m - n)/3 \)

Three objective questions make up the remainder of this section. They are multiple-choice questions (4-response
type), one of each of which deal with the concepts of transposition, simultaneous equations, and quadratic equations.

Section 3 of Part 2 deals with the technical vocabulary of mathematics.

The material for this section is based upon an extensive research involving the technical vocabularies of a number of mathematics texts.

The procedure used in selecting the terms is the same procedure used for a series of technical vocabulary studies of public-school subjects.

The most frequently occurring technical terms were incorporated in the test.

The following expressions were used:

\[ \frac{1}{2} \sqrt{bm} \quad (a + b) \quad 2r^2m - 7mxs^3 \quad (a - b + c)^2 \]

In spaces provided the student was instructed to copy the following:

1. The coefficients of \( x \).
2. The exponent of \( r \).
3. Any letter that is squared or cubed.
4. The highest power.
5. The term that must be a root.
6. The term that is affected by the radical.
7. The term of which the square root could be found.
8. The expression that is not expanded.
9. The binomial.
10. The expression that is a factor of \( a^2 - b^2 \).

The next question is a multiple-choice type of question (four responses). The question is, "What is the bisector of an angle?"
The last two items of this section are concerned with graphs and the solution of equations by graphs. A small section of cross-section paper (1\(\frac{1}{2}\) inches square) ruled in 1/8-inch squares is given, and the subject is asked to locate the point whose abscissa is 3 and whose ordinate is -4. It may be worth mentioning that the terms abscissa and ordinate in this question as well as bisector in the previous problem come directly under the classification of technical vocabulary. Without a knowledge of the meaning of these terms, despite the fact that the problems are very simple, the subject is helpless.

The last problem is a multiple-response type of question in which several suggested equations are given, one of which is represented by the line drawn on the graph. The subject is required to identify the correct answer among those suggested. The suggested answers are:

1. \(3x + 5 = 2\)
2. \(x^2 - 3x - 4 = 25\)
3. \(-3y = 4x\)
4. \(x^2 - 2xy + y^2 = 49\)
5. \(3x = y - 13\)

To summarize the mathematics test, then, the following points may be repeated:

1. The test items used were selected on the bases of wide analyses of textbooks in science (especially chemistry, physics, and mathematics). Only items involving such skills as were actually necessary in solving the
problems in the texts analyzed were used.

2. The technical vocabulary items were obtained from the sources mentioned above and also from analyses of a large number of public-school texts in mathematics (arithmetic, algebra, and geometry).

3. The test is designed to ascertain whether the freshmen to whom it was given, and who expect to take courses in mathematics and science, can use the skills and formulae with satisfactory facility and have an adequate knowledge of the mathematical concepts and technical vocabulary used.

4. The test was not a time-limit test, but was a work-limit test in that each student was allowed to complete as much of the test as he could within the fifty minutes of testing time allotted; practically all students found the time limit adequate for completing all the test that they could. The total number of points possible on the test was 62, as the first twenty-five problems were divided into (a) and (b) parts that involved the same concepts, and both parts were required to be answered correctly for any credit.

5. A brief outline of the test is as follows:

Part 1. Problems

I. Arithmetic: six problems divided into (a) and (b) parts, involving the following skills:

A. Addition of common fractions
B. Division of common fractions
C. Division of decimals
D. Percentage involving whole numbers and decimals
E. Expressions of relationships between numbers, as:
   1. Common fractions
   2. Per cents
   3. Decimals

II. Algebraic skills: nineteen problems each divided into
    (a) and (b) parts involving the following skills:
A. Addition
   1. Whole numbers (monomials)
   2. Fractions
      a. Monomials
      b. Binomials
B. Subtraction
   1. Whole numbers (monomials)
C. Multiplication
   1. Whole numbers (monomials)
   2. Fractions
      a. Monomials
      b. Binomials
D. Division
   1. Fractions
      a. Monomials
      b. Binomials
E. Simplification of terms
   1. Removing parentheses
   2. Collecting terms
F. Finding the value of the unknown (x or y)
   1. Transposing and collecting
      a. Whole numbers
      b. Fractions
G. Substitution of known values
   1. Whole numbers
   2. Fractions
H. Proportions (rewriting equations to show the value
    of one term; e.g. \( \frac{a}{b} = \frac{c}{d} \))

Part 2. Necessary Concepts

I. Units of measure
A. English
   1. Measure
      a. Linear: inches, feet, yards, miles
      b. Square: square rods, acres
      c. Cubic: feet, yards
      d. Angles: seconds, degrees
   2. Weight
      a. Ounces, pounds, tons
B. Metric
1. Measure
   a. Linear: millimeter, centimeter, meter
   b. Cubic: cubic centimeter, liter
2. Weight
   a. Gram, kilogram

II. Understanding of equations
A. Adding to one side of a known equation (whole numbers)
B. Subtracting from one side of a known equation (whole numbers)
C. Dividing one side of a known equation (whole number)
D. Squaring one side of an equation.
E. Multiplying one side of an equation by a given number.
F. Extracting square root of one side of an equation
G. Multiple-choice questions involving a knowledge of:
   1. Transposition
   2. Simultaneous equations
   3. Quadratic equations

III. Technical vocabulary of mathematics
A. Vocabulary used: coefficient, unknown, exponent, square and cube, highest power, root, radical, square root, expanded term, binomial, factor, bisector, graph, abscissa, and ordinate.

4. The Freshman Week History Test.—This test is based on an elaborate analysis of numerous textbooks in both American and European history. These analyses have been the object of several researches that have been carried on under the supervision and direction of Dr. L. C. Pressey. The researches have been made as individual researches, problems under psychology course 650, class projects, and for obtaining data for masters’ theses and doctoral dissertations.

About the Ohio State University campus several of these researches not only in American and European history
but also in the fields of mathematics, science, art, home economics, music, etc. are known as vocabulary studies. The purpose of the analyses of textbooks is of course to ascertain what technical vocabulary is needed for a mastery of a course in the subject.

Frequency of mention was the criterion adopted for the importance of the technical terms.

In addition to technical vocabulary necessary historical concepts, dates, and certain geographical information with respect to cities, countries, states, bodies of water, etc. were also obtained. The geographical terms came not only from history analyses, but also from the analyses of several geography texts. Particular attention was given to geographical terms of historical significance.

The test was designed both for students who expected to take American history as well as for students who expected to take European history.

The purpose of the test is, of course, to determine the previous preparation of the college freshman to whom it is given and from this preparation to make a prediction as to his probable success in history courses.

Purposes of the test, however, will be discussed later under the head of Prediction of Success in History. In the present chapter it will be sufficient to explain the materials and methods of testing.
The test is divided into several parts. Each of these is preceded by specific directions to be followed for that particular section.

Part 1 is common to both American and European history. It is composed of one hundred questions dealing with technical vocabulary and historical concepts. These one hundred questions are of the multiple-response type, and one, two, three, or four answers are required for each question. The directions which appear on the test blank for this section follow:

"On the next few pages there are some questions. Each question is followed by a number of possible answers. You are to answer the questions by drawing a line under the answer that you think is correct. Some of the questions call for two, three, or four answers, but most of them call for only one. Thus the first question has only one answer; the fourth has two answers; the fifteenth has three answers. Be sure to mark exactly the number of answers called for by each question. If you mark too many or too few, the question will not count."

To give further information as to the type of questions used and responses expected, a few questions from the test will be quoted here.

1. Which is an official in the executive branch of government? alderman, senator, governor, judge.
6. Who belongs to the House? senators, ambassadors, the ruling family, representatives


41. What three words refer to the rights of the people to act directly? publicity, toleration, referendum, squatter, sovereignty, recall, propaganda, repeal, illiteracy, constitution, initiative.

As was stated above, the words for both the questions and the responses—the correct as well as the incorrect responses—were obtained from analyses of textbooks in history.

If a student was to answer the questions correctly, it would be necessary for him to understand the vocabulary of both the questions and the answers.

The responses to the one hundred questions involves 160 historical concepts for right responses only, besides the concepts contained in the questions. The following table gives the technical vocabulary necessary for an understanding of the question and the identification of the correct response.

<table>
<thead>
<tr>
<th>abdicate</th>
<th>allegiance</th>
<th>arctic</th>
<th>Baptist</th>
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<tbody>
<tr>
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<td>alliance</td>
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<td>abrogate</td>
<td>allies</td>
<td>articles</td>
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<td>ambassador</td>
<td>assault</td>
<td>bolshevism</td>
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<td>accession</td>
<td>amendment</td>
<td>assessment</td>
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<td>administration</td>
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<td>agreement</td>
<td>appropriation</td>
<td>ballot</td>
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<tr>
<td>alien</td>
<td>arbitration</td>
<td>bankruptcy</td>
<td>candidate</td>
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</tbody>
</table>
Part 2 of the test deals with the geographical background for history.

As was stated before, one division of Part 2 was designed for those students who expected to enroll in European history, while the other division was for American history students. If the student did not know which branch of history he expected to take, or did not expect to take any history, he was given his choice as to which divisions of the test he would take.

The European history division involved the location of one hundred twenty cities, states, countries, bodies of water, etc. It is divided into four sections. Each of the first three sections is furnished with a map, which is lettered or numbered or both.

Section 1 consists of a map of Europe on which the location of twenty countries is indicated by numbers. In the margin below the map the countries are named, and the subject is required to copy the number of each country after its name.

The countries named are Turkey, Denmark, Belgium,
Jugoslavia, Holland, Sweden, Poland, Crimea, Greece, Morroco, Bulgaria, Algeria, Roumania, Albania, Hungary, Sicily, Switzerland, Czechoslovakia, Prussia, Spain.

Section 2 also consists of a map of Europe on which the locations of twenty-two cities are indicated by letters. The subject is directed to copy the letter that stands for each city after the name of the city, which appears in the margin.

The cities named are Athens, Geneva, Moscow, Hamburg, Amsterdam, Marseilles, Madrid, Florence, Rome, Berlin, Gibraltar, Warsaw, Rheims, Lisbon, Vienna, Antwerp, Cologne, Bordeaux, Constantinople, Budapest, St. Petersburg, Petrograd, or Leningrad.

Section 3 is similar to sections 1 and 2 in that it consists of a marked map. The map, however, is of Asia. The locations of the countries are marked by numbers, while the locations of the cities are indicated by letters. The subject is instructed to copy the number or letter which indicates the location of each country or city after its name. The names of the countries and cities appear in the margin of the map. There are ten cities and the same number of countries located on the map.

The cities indicated are as follows: Calcutta, Hongkong, Alexandria, Tokio, Suez, Vladivostok, Bagdad, Jerusalem, Peking, Bombay.
The countries on this map are Siberia, Arabia, Afghanistan, India, Korea, Philippine Islands, Syria, Persia, Palestine, Manchuria.

Section 4 is composed of a series of fourteen multiple-choice questions (four responses) that deal largely with rivers, bodies of water, mountain ranges, and peninsulas of the Eastern Hemisphere. The subject is instructed to answer the questions by underlining the correct word.

The items covered in this test are as follows: Aegean, Baltic, North, Adriatic, and Black seas; the Rhine, Danube, Volga, Ganges, and Nile rivers; the Balkan Peninsula, Straits of the Bosporus, and Pyrenees Mountains.

The geographical background for American history. -- Students expecting to take American history were instructed to take this division of the test. This division is divided into five sections as follows:

Section 1 consists of a map of the United States. The locations of fourteen states are indicated by figures on the map, and the names of the states appear in the margin of the page. The subject is directed to put the number that stands for the state on the map after the name of the state in the margin. The names of the states are Texas, Nevada, Arizona, Arkansas, Maine, Iowa, Oregon, Kansas, Utah, Illinois, Delaware, Florida, North Carolina, North Dakota, New Jersey, Alabama.
Section 2 in the American history division is similar to the corresponding section in the European history section. An outline map of the United States is given. The locations of twenty-four cities are indicated by letters on the map. The names of the cities appear in the margin below, and the subject is instructed to place the letter which indicates the location of the city after the name of the city. The cities named are Baltimore, Denver, Montreal, Savannah, Santa Fe, Providence, New Orleans, Los Angeles, Louisville, Omaha, Memphis, Plymouth, Minneapolis, San Francisco, Detroit, New Haven, St. Louis, Jamestown, Pittsburgh, Concord, Richmond, Albany, Philadelphia, Quebec.

Section 3.—This section consists of an outline map of North America on which the locations of certain gulfs, bays, lakes, rivers, islands, and seas are indicated by numbers. The names of these items appear in the margin, and each name is to be matched with its respective number. There are fourteen items in this section: Gulf of Mexico; Hudson and Chesapeake bays, lakes Champlain, Erie, Superior, Great Salt Lake; St. Lawrence, Potomac, Columbia, Rio Grande, and Hudson rivers; Long Island; Caribbean Sea.

It may be noted that all of the items in this test have no little amount of historical significance attached to them.
Section 4.--This section consists of twenty-three countries, states, provinces, island possessions, etc. to be identified with respect to the continent in which they are located. The subject is directed to place a figure 1 in front of all countries in Central or South America; a figure 2 in front of all countries that are in Europe; a figure 3 in all countries that are in Africa; a figure 4 in front of all countries that are in Asia; and a figure 5 in front of all countries that are not in any of the places named.

The countries and provinces named are Hawaii, Venezuela, Guatemala, Porto Rico, India, Argentina, Portugal, Chile, Liberia, Alaska, Mexico, Nicaragua, Congo, Holland, Palestine, China, Australia, Nova Scotia, Peru, Belgium, Panama, Prussia, Scandinavia.

Section 5.--In this section 3 questions deal with conceptions of geographical distance, while the other 3 deal with the locations of cities and a group of islands (West Indies).

All six questions are of the multiple-choice type. The question is stated and four responses suggested. The subject is to identify the correct response.

To summarize the Freshman Week History Test, the following points may be restated.

1. The test was devised for the purpose of determining the previous preparation of Ohio State University freshmen in American or European history or both.
It also is hoped that on the basis of previous preparation as indicated by test results, a prediction or prognosis can be made as to the outcome of history courses in which the freshmen will enroll.

2. The materials used for test items were selected on the basis of extensive researches and textbook analyses to ascertain the technical vocabulary peculiar to history, historical concepts and geographical information necessary for an understanding of history.

3. A brief outline of the test follows:

Part 1. 100 questions involving the uses of 160 technical words and historical concepts in their answers.

A. The questions are of the multiple-choice type and have four or more suggested responses.

B. The number of responses required for each question varies from one to four (160 responses in all).

Part 2. Geographical background for history

A. European history background
   1. Location of 20 countries on map of Europe
   2. Location of 22 cities on map of Europe
   3. Location of 10 countries and 10 cities on outline map of Asia.
   4. Fourteen multiple-response questions dealing with the locations of rivers, bodies of water, mountain ranges, and peninsulas.

B. American history background
   1. Location of 16 states on an outline map of the United States
   2. The location of 24 cities on an outline map of the United States.
   3. Location of certain gulfs, bays, lakes, rivers, islands, and seas on an outline map of North America.
4. Identification of 23 countries, states, provinces, 
   island possessions etc. with respect to the 
   continents on which they are or are not lo- 
   cated. 
5. Six multiple-choice questions 
   a. Three questions dealing with geographical 
      distance and location 
   b. Two questions dealing with the locations 
      of cities and one with the location of a 
      group of islands (West Indies).

5. The Freshman Week Language Test.—Like the other 
   Freshman Week tests, the language test was constructed from 
   materials that were selected as a result of extensive re- 
   searches. The researches consisted of the analysis of 
   eight language textbooks in four different languages in 
   addition to the analysis of numerous text-and handbooks of 
   English usage.

   A list of 260 different concepts of language was 
   determined by these analyses, and this group of concepts 
   was deleted to a group of 86 which was used in the test. 
   The importance of the 86 items chosen was made on the basis 
   of frequency of mention in the various textbooks analyzed. 

   This list of most frequently occurring items was 
   submitted to a group of twelve language professors for 
   their opinions as to the relative importance of the items 
   contained in the lists.

   We have, then, in contrast to the often used method 
   of asking the different authorities for their suggestions 
   as to the items which they considered important for the
mastery of language, a different technique for selecting the most important concepts. First, the analyses of the abovementioned textbooks, furnished all of the concepts (260) that were contained in the sources, and on the basis of frequency of mention this list was delimited to 86. Secondly, this list of most frequently occurring concepts was submitted to the language professors for their opinions as to the relative importance of the items. The usual procedure, as intimated above, is that of asking the authorities—or perhaps it would be more nearly correct to say the instructors—to write out a list of the concepts which they deem to be most important.

The language professors divided the list of 86 concepts into practically equal parts. Forty-five of the concepts were regarded as basic for introductory work, whereas the remaining forty-one were demanded for more advanced courses.

These eighty-six concepts were then incorporated into the Freshman Week Language Test.

The language test, like other subject-matter tests given during Freshman Week, was for the purpose of determining the academic background of the freshman. The language test was of course specifically to determine the language preparation of the individual. The background information is necessary in making a prognosis or prediction of the
academic success that the individual will have—or rather should have—in language courses taken during his freshman year in college.

The test consisted of forty items, but each of the items contained one or more of the language concepts—eighty-six in all. Usually there were two or more of the same type of concepts as well as two or more separate concepts. This repetition of concepts was to guard, as far as possible, against the subject's making a lucky guess as to the correct answer. A further precaution against guessing will be discussed under the head of scoring the tests.

The language test, unlike the other tests of the series, was made in only one section, and one general set of directions appeared at the beginning of the test. These are:

"There are exact directions for marking each of the sentences below. Read these directions, then mark the sentences. If you come to something that you do not understand, do not take time to puzzle over it, but skip it and go on to the next sentence."

It will be noted that there were specific directions for each item so that if the subject understood the vocabulary and was familiar with the concept, there could be no question about his correctly marking the blank.

This test, as were the other Freshman Week tests
of this series, was a work-limit test. A fifty-minute period was allowed for the work, but practically all the subjects had completed marking their blanks before the period closed; hence we may conclude that all or practically all of the students had gone as far as they could.

It will be noted in the analysis of the test which follows that the mechanics of grammar such as capitalization and punctuation were entirely left out of the test and that sentence structure was mentioned but once. This absence of mechanics of grammar makes the language test significantly different from the tests that have been used heretofore in Freshman Week exercises. This phase (mechanics) was covered in a separate test which dealt, however, largely with sentence structure. It has been found (Pressey, Preparation of Freshmen, Journ. Higher Edu., Vol. 1, No. 3, March 1930), however, that mechanics, especially as indicated by a proof-reading type of test, have been mastered by a much larger percentage of students than have the items covered in the present language test.

It was previously stated that the language test was not divided into parts and sections, but for the purpose of analysis and description it has been convenient to divide it into four sections, each section containing groups of concepts that are related or similar.

An analysis of the test follows:
Section 1 deals only with identifying seven of the eight parts of speech. The parts of speech are noun, pronoun, verb, adjective, adverb, conjunction, and preposition. Sentence 1 calls for the identification of nouns and adjectives, sentence 2 for verbs and pronouns, and sentence 3 for adverbs, conjunctions, and prepositions. Two or more instances of the different parts of speech, with the exception of adverbs, conjunctions, and prepositions, of which there is but one each, occur in the sentences given.

Section 2 deals with what I have arbitrarily called the characteristics or properties of different parts of speech. The properties of the various parts of speech, together with the number of the sentence in which they appear, will aid in understanding the test.

Nouns:—The usual properties of nouns—gender, number, and case, the uses of appositives, antecedents of pronouns, predicate nouns, and agents, and other properties—declension, syntax, inflection, and agreement—appear in certain items of the test.

A fuller description of the properties and uses of the various parts of speech together with the item of the test in which they appear will be given in the summary of this section. An idea of the different properties of nouns and pronouns is given by the following illustration:
Gender—masculine, feminine, and neuter—appears in item 13 of the test. The directions for this item are:

"In the following sentence underline once each word (noun or pronoun) that is in the feminine gender, underline twice each word that is in the masculine gender, and underline three times each word that is in the neuter gender."

The sentence is as follows: Her sister and her aunt went to the theatre where they saw a famous actor in a play in which he was the star.

Pronouns.—The properties, classes, and uses of pronouns were treated in a similar manner. The properties of the pronouns are gender, person, number, and case; the classes are personal, possessive, relative, interrogative, demonstrative, and reflexive; the uses are as modifiers or as predicate adjectives.

Verbs.—The properties of verbs are number, tense, voice, mood, conjugation, principal parts, and inflection; the types or classes of verbs considered are auxiliary, transitive, intransitive, regular, irregular, and impersonal; the verbal forms are infinitives and participles.

Adjectives.—The properties of adjectives are degree (positive, comparative, and superlative); the uses are as modifiers and as predicate adjectives. Definite and indefinite articles are also listed under the head of
adjectives.

Adverbs, prepositions, and conjunctions were not further analyzed with respect to class, properties, uses, etc. The only demand of familiarity with these three parts of speech made of the student was an ability to identify each of them one or more times in the item of the test in which they appeared. It may be further stated that all three of these parts of speech appeared together in one item (No. 3) of the test. The directions for this item and the exercise are as follows:

"In the following sentence put a figure 1 under the adverb, a figure 2 under the conjunction, and a figure 3 under the preposition." The sentence is: He struck the ball viciously, but it fell into an outfielder's glove.

Section 3. Sentences and parts of sentences.—The parts of sentences considered are clauses, subject, predicate, object, and phrases.

The kinds of sentences to be identified were negative, those containing indirect quotations, interrogative, those with inverted word order, contrary-to-fact statements, and those in which there was an error in sentence structure.

Section 4. Numbers, letters, words, and groups of words.—This section might well be called the miscellaneous, clearing-house, or dumping-ground section of the test, as
it contains a variety of items that would not well fit into any of the sections listed above. In it are considered cardinal and ordinal numbers or numerals, vowel and consonant letters, prefixes, suffixes, accents, diminutive forms of words, and idioms as groups of words.

To summarize the Freshman Week Language Test the following points may be repeated:

1. The items used in the test were selected on the basis of frequency of mentions in eight language textbooks in four different languages in addition to the analyses of numerous text- and handbooks of English usage.

2. These various analyses yielded a total of 260 concepts, 174 of which were discarded because of lack of frequency of universal mention (they might be peculiar to one language or obsolete in form). The other 86 were incorporated into the test.

3. This list of 86 concepts was submitted to twelve language professors who evaluated them according to the merit of the item. Forty-five of the concepts were regarded by this group as essential for introductory language courses. The other forty-one concepts were demanded for more advanced work.

4. The language test was given to ascertain the previous preparation as background that the freshman has for language courses, and from this indication to predict his probable success in language.
5. The test consisted of forty items; each item contained one or more concepts and usually two or three instances of the same concept appeared in each item; i.e. if the item called for the identification of nouns and adjectives as the first item of the test, two or more nouns as well as two or more adjectives were given in the sentence.

6. The test was a work-limit test, as practically all students finished all they could of the test in the fifty minutes allowed.

7. The test is composed of but one section. The instructions consist of a set of general directions for the entire test and specific directions for each item.

8. The test may be easily divided into sections for convenience in analysis.

An outline of the test listing the concepts employed and the number of the item containing the concept follows:

Section 1 contains seven of the eight parts of speech. There are nouns, pronouns, verbs, adjectives, adverbs, prepositions, and conjunctions (test items 1, 2, and 3).
Section 2. Characteristics of the different parts of speech.

A. Nouns
1. Gender
   a. Masculine (13)*
   b. Feminine
   c. Neuter
2. Number
   a. Singular
   b. Plural (4)
3. Case
   a. Nominative
   b. Accusative (33, 34)
   c. Genitive
   d. Dative
4. Uses
   a. Appositives
   b. Antecedents of pronoun (11, 31, 39)
   c. Predicate noun
   d. Agents
5. Other properties
   a. Declension (27)
   b. Syntax (40)
   c. Inflection (28)
   d. Agreement (10)

B. Pronouns
1. Gender
   a. Masculine
   b. Feminine (13)
   c. Neuter
2. Number
   a. Singular
   b. Plural (4)
3. Case
   a. Nominative
   b. Accusative
   c. Genitive (33, 34)
   d. Dative
4. Person
   a. First
   b. Second
   c. Third
5. Classes
   a. Personal
   b. Possessive
   c. Relative (5, 22, 37)
   d. Interrogative
   e. Demonstrative
   f. Reflexive

*The numbers in parentheses refer to the number of the test item in which the different concepts occur.

C. Verbs
1. Number
   a. Singular
   b. Plural (4)
2. Tense
   a. Present
   b. Past
   c. Future
   d. Imperfect (9, 23, 36)
   e. Perfect
   f. Past perfect
   g. Conditional
3. Voice
   a. Active
   b. Passive (14)
4. Mood
   a. Indicative
   b. Imperative (26)
   c. Subjunctive
5. Types or classes
   a. Auxiliary
   b. Transitive
   c. Intransitive (15, 16, 17, 36)
   d. Regular
   e. Irregular
   f. Impersonal
6. Other properties
   a. Conjugation (27)
   b. Principal parts (32)
7. Verbalas
   a. Infinitives (15)
   b. Participles (19)
   1. Present
   2. Past
D. Adjectives
   1. Degree
      a. Positive
      b. Comparative (29)*
      c. Superlative
   2. Uses
      a. Modifiers (10)
      b. Predicate adjectives (31)
3. Articles
   a. Definite
   b. Indefinite (25)

Section 3. Sentences and parts of sentences.

A. Parts of sentences
   1. Clauses
      a. Main or independent
      b. Subordinate or dependent (6)
   2. Subject (7)
   3. Predicate (complete) (8)
      a. Noun (31)
      b. Adjective
   4. Object
      a. Direct (7)
      b. Indirect (24)
   5. Phrases (8)
B. Kinds of sentences
   1. Negative (18)
   2. Indirect quotation (18)
   3. Interrogative (18)
   4. Inverted word order (35)
   5. Contrary-to-fact statement (38)
   6. Error in sentence structure (38)

Section 4. Numbers, letters, words, and groups of words.

A. Numerals
   1. Cardinal
   2. Ordinal (30)
B. Letters
   1. Vowels
   2. Consonants (20)
C. Words
   1. Prefixes)
   2. Suffixes}(21)
   3. Accents
   4. Inflections (28)
   5. Diminutives (29)
D. Groups of words
   1. Idioms (24)

*The numbers in parentheses refer to the number of the test item in which the different concepts occur.
6. The Freshman Week Reading Test.--Reading is one of the most elementary and basic of the academic skills. In fact one of the earliest tasks with which the child is confronted when he enters school is to learn to read.

Since the origin of standardized tests perhaps few subjects if any, other than possibly arithmetic, has been the subject of wider educational investigation and research. Numerous techniques have been initiated for teaching reading, and scores of tests, both of rate and of comprehension have been devised.

There are few who will deny the necessity of reading, both accurate and rapid. There has arisen recently, however, much discussion as to the possibility of testing both rate and comprehension at the same time.

It is well-established fact that all college students do some reading. Those students who take courses primarily in the content or reading subjects, however, do a very great deal more reading than do the students who are enrolled in courses that are more problematical or laboratory in nature.

Researches in the field of reading show that both the rate and the comprehension vary enormously depending upon several factors such as the type of reading material, the purpose for which the reading is done, the instructions received by the students before starting to read, the vocabulary, the familiarity with the subject matter, and various other factors.
With the aforementioned information at hand a reading test was devised which was designed to incorporate as many desirable points as possible. The rate and comprehension were treated or tested separately, the type of subject matter varied from easy to hard, and contained samplings from various fields. The same instructions were given to all the subjects, and the purpose of the test likewise was explained, hence a number of the factors which were mentioned in the foregoing paragraph as influencing the rate and comprehension of reading were controlled.

The purpose of the test was to ascertain the reading skill, both in rate and comprehension. It may be added that those students who read very slowly can compensate for this slowness of rate only by spending an additional amount of time on their reading. Or another alternative is quite readily possible for most students: that of increasing reading rate by practice, reading selectively and becoming familiar with the type of reading required.

The reading test, unlike the other tests of the Freshman Week series, was a time-limit rather than a work-limit test. A time limit is absolutely essential for a test of reading rate. Likewise most tests, unless the items are extremely difficult, could be answered with a high degree of accuracy if only enough time is given.

The types of reading material covered in the test
are samplings of what the college student could expect to find in the preparation for his course work.

An analysis is necessary for an understanding of the make-up of the test. It is a twelve-page folder the composition of which is as follows:

Page 1.—This test might well be called a formula-reading and interpreting test. Three formulae are given. The first is \( M = P + Q \), and four multiple-response questions, each with four suggested responses, follow. The second formula is \( s = \frac{1}{2}qt^2 \), and three of the same type of questions are asked. Finally the formula \( f/w = h/l \) is given, and three questions of the above type follow.

There are then on page 1 three formulae about which ten questions are asked. The directions to the subject are: "Look at the formulae below, then answer the questions about them by checking the right answers.

Pages 2, 3, 4, 5, and 6 furnish the materials for the rate of reading. On these pages approximately the upper one-half of each page is devoted to a couple of paragraphs of reading material on various subjects, while the lower half is filled with four multiple-choice questions of the four-response type.

The fields covered on these pages are American Literature, American history, chemistry, botany, French grammar, and mathematics. There are in these six selections
1203 words.

The paragraphs on American literature were concerning the characteristics of Franklin. The American history section concerned the Louisiana purchase. The paragraphs on chemistry were about ionization. Those on botany dealt with the types of plant cells. The French grammar section included information on the formation of tenses, agreement, etc. The section on mathematics had to do with the properties of equations.

At the close of each paragraph a simple question was asked concerning the content of the paragraph or some phase of it. The questions were to be answered by underlining the response yes or no. No consideration was paid as to the correctness of these answers. The only purpose they served was as a sort of check on whether the subject actually read the material.

For the test on reading rate the subject was instructed to begin reading on page 2 (the American literature section) and continue reading until time was called. Six minutes was allowed for the text, and at the expiration of that period of time, time was called and the subject was asked to draw a ring around the last word he had read. To determine reading rate the words read were counted and the number divided by six to get the rate per minute.
Pages 8, 9, and 10 deal with the solution of problems. The solutions for these problems are readily evident if the reading has been comprehended.

Problem 1 deals with distance and traveling time; problem 2 with investment and interest; problem 3 with weights and measures; problem 4 with chemical compounds; and problem five with the relationship of numbers.

Two questions are asked about each of the problems, and each question requires one or more answers. An exception to the above statement occurs in case of question 5, about which there are five questions asked and five answers required. There is a total possible score of 15 points for these five questions.

Pages 11 and 12 consist of three drawings as follows: On page 11 appears a drawing of a highly magnified motor neuron, and a drawing representing the development of a shore line. Three questions are asked about each drawing. Page 12 consists of a graph showing the number of deaths resulting from each of two diseases during the different months of the year. Four questions are asked concerning the graph.

Each question correctly answered is scored one point. There is a total of sixty-two possible points in the list. The time limit for the test exclusive of the time devoted to the speed test is 41 minutes.
To summarize the points concerning the reading test, then, the following may be said:

1. The test was devised to ascertain both the reading rate and the degree of comprehension of the freshmen.

2. Skill in reading is recognized as essential for satisfactory academic progress.

3. Numerous factors such as purpose, type of material, vocabulary, familiarity of material, directions etc. affect both the rate and the comprehension of reading.

4. A variety of types of subject matter is included in the test.

5. Rate and comprehension were tested separately.

6. The test for reading rate consisted of paragraphs totaling 1200 words. The time limit was six minutes.

7. A description of the test follows:

   The test consists of a pamphlet 12 pages in length.

   Page 1 deals with the reading of formulae and answering questions concerning them. There are three formulae and ten questions.

   Pages 2, 3, 4, 5, 6, and 7 each deal with a different subject two paragraphs in length. About each of these selections four questions are asked. There are then 24 questions in this section.
Pages 8, 9, and 10 deal with problems. The problems are two of algebra, and one each of arithmetic, physics, and chemistry. There is a total of 17 points in this section.

Pages 11 and 12 deal with the interpretation of graphs and drawings. There are two drawings and one graph. Three questions are asked about each of the drawings and four about the graph—a total of 10 points for the last section. The total number of points is 61.
7. **Summary of the Tests.**—All the tests which were used as the material for this research have been carefully analyzed.

A brief recapitulation of the material concerning the tests follows:

a. **The Ohio State University Psychological Test.** This test is further subdivided. The test is first considered as a whole, then the reading test is considered as a second test. The entire test is frequently referred to as the University Intelligence Test.

The test consists of twenty pages of directions and test items. The sub-tests are distributed as follows: one page of general directions, two of practice tests, two of arithmetic, two of vocabulary, four of analogies, two of digit combinations, and seven of reading. The time allowed for the various tests varies from seven minutes to thirty-six minutes, and the number of points from 17 to 105. The total time for the test is 102 minutes, and the total possible number of points is 395.

b. **The Ohio State University reading test forms** a part of the intelligence test and was described as a part of that test.

c. **The Freshman Week Mathematics Test** consisted of a 7-page folder divided into two parts as follows: part 1 consisted of four pages of problems. There were twenty-
five problems (2 examples in each item). Six of the problems were arithmetic, and the other nineteen were algebra. Both parts of each item were correct before any credit was given for the item. There were twenty-five possible points in part 1.

Of the three remaining pages of the test one page was devoted to necessary concepts (13 items), one page to understanding of equations (9 items), and one page to the technical vocabulary of mathematics (15 items).

There were in this part a total of 36 points.

The total possible score for the entire test was 62.

d. The Freshman Week History Test was a 15-page folder divided into three parts. The first part consisted of seven pages containing items embodying 160 historical concepts. The other two parts concerned geographical background for history, one part for American history students and the other part for European history students. There were four pages devoted to each American and European geographical background. There were a total of 180 cities, states, countries, etc. mentioned which were to be located geographically.

The test was a work-limit test. The maximum score was 280 points.

e. The Freshman Week Language Test. This test was a 6-page folder which was not divided into parts. There
were forty items in the test, and each item contained one or more language concepts. The total number of concepts was 86.

f. The reading test was a 12-page folder divided into four different types of reading. Page 1 consisted of a group of formulae about which ten questions were asked. Pages 2, 3, 4, 5, 6, and 7 contained material from different fields. A total of 24 points was allotted to this section. In this section also appeared 1200 words in paragraphs and the rate of reading was determined from this material. Pages 8, 9, and 10 consisted of five problems whose answers were indicated in the reading. There were 17 points allotted to the problems. Pages 11 and 12 consisted of three diagrams which were to be interpreted. There were 10 points in this section. Six minutes were devoted to testing speed of reading and 41 minutes to comprehension. The maximum score on the reading test was 62.

B. The Students Used in the Research.--During the autumn quarter 1929 over 2500 freshmen enrolled for the first time in the Ohio State University. These freshmen were required to report a week in advance of the opening of school and to participate in a Freshman Week program. Among other activities the program consisted of taking the Ohio State University Psychological Test and a battery of previous-preparation tests. The latter were known as the
Freshman Week Tests. As has previously been explained, the items in these tests were selected on the basis of extensive researches that were designed to ascertain the importance of the items. These items, since they come from sources with which the college freshman is supposed to be familiar, should give an indication of the previous preparation of the freshmen in the subjects tested. The subjects were reading, history, mathematics, and language.

Both the general and specific prognoses were made for students selected from the more than 2500 who entered the university during the autumn quarter 1929.

The general prognoses were made in the colleges of Arts and Education. The Education group consisted of all subjects who had taken all the tests and remained in the university for a quarter. There were 241 in this group. To check on the accuracy of sampling and prediction a similar group of 100 was selected from the College of Arts. The Arts group, however, did not take the Freshman Week Reading Test.

The language prognosis concerned all the students in the colleges of Arts, Commerce, and Education who had taken the Freshman Week Language Test and a 401 language course (French, Spanish, German, or Latin). There were 402 such students.

The mathematics group was made up of all the students
who had taken the intelligence, mathematics, and Fresh-
man Week reading tests and had completed the course in
mathematics 431. These students, of whom there were 287,
were in the colleges of Agriculture and Engineering.

The history prognosis was in the colleges of Arts
and Commerce. It concerned the students who had taken
the Freshman Week history and language tests and history
403. There were 386 in the group that had taken the his-
tory tests and the course and 263 who had taken both the
history and language tests and the course. They were from
the colleges of Arts and Commerce.

The chemistry prognoses were in the colleges of
Agriculture and Engineering for the courses in chemistry
401 and 403. There were 181 in the 401 chemistry group
and 343 in the 403 chemistry group. The intelligence,
reading, and mathematics tests were taken by these groups.

A table showing the groups used in this study
follows:

<table>
<thead>
<tr>
<th>Number</th>
<th>Tests</th>
<th>College</th>
<th>Prognosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>241</td>
<td>All</td>
<td>Education</td>
<td>General</td>
</tr>
<tr>
<td>402</td>
<td>Intel. and language</td>
<td>Arts,Com.,Educ.</td>
<td>Lang. 401</td>
</tr>
<tr>
<td>100</td>
<td>All except F.W. reading</td>
<td>Arts</td>
<td>General</td>
</tr>
<tr>
<td>386</td>
<td>History</td>
<td>Arts &amp; Commerce</td>
<td>History 403</td>
</tr>
<tr>
<td>263</td>
<td>History and language</td>
<td>Arts &amp; Commerce</td>
<td>History 403</td>
</tr>
<tr>
<td>343</td>
<td>Readg.,intel.,math.</td>
<td>Agric. &amp; Engr.</td>
<td>Chem. 411</td>
</tr>
<tr>
<td>181</td>
<td>Readg.,intell.,math.</td>
<td>Agric. &amp; Engr.</td>
<td>Chem. 401</td>
</tr>
</tbody>
</table>
C. The Selection of the Subjects

1. For General Prognosis in the College of Education.--It will be recalled that the College of Education group was the only group of freshmen that was subjected to the entire battery of tests that made up the testing procedure for the week, but not all of the College of Education students took all the tests.

Tests in reading and language were administered to this group during a freshman survey period as soon after Freshman Week as possible.

The selection of subjects for this particular prognosis involved all the freshmen who took all the tests (intelligence, reading, mathematics, history, and language).

This group originally numbered over 400, but some withdrew from the university, transferred to other colleges, etc. until the number of survivors at the end of the first quarter was 241.

This group of 241 subjects were then first-quarter freshmen who had enrolled for the first time at Ohio State University during the autumn quarter 1929, who had taken all the tests given during Freshman Week, and had remained in school for the full quarter.

a. As a means of checking up on the accuracy of the general prognosis in the College of Education a group of 100 students in the College of Arts was selected.
This group, however, was not given the Freshman Week reading test, and in computing both the intercorrelations and the multiple correlations no Freshman Week reading was included. Since the results from this sampling so far as the multiple correlations and correlations of the separate tests with the criteria were concerned corresponded so closely with the results found for the College of Education group, no further mention will be made of the general Arts prognosis. The intercorrelations among the separate tests, however, were much higher for the Arts group than for the Education group.

2. For Prognosis in Language.--This is of course a specific prognosis. The subjects for this prognosis were students enrolled in the colleges of Arts, Commerce, and Education who had taken the Freshman Week Language Test and who had completed a 401 (beginner's) course in French, German, Latin, or Spanish. The number of students used in this prognosis was 402.

3. For Prognosis in Mathematics.--The subjects for this section consisted of all subjects in the colleges of Engineering and Agriculture who took the Freshman Week mathematics and reading tests and had completed courses in mathematics 400 or 431.

There were 287 students who had taken the intelligence, mathematics, and reading tests and mathematics 431.
4. For Prognosis in History.--The subjects consisted of those students in the college of Arts, Commerce, and Education who had taken the intelligence and history tests and had completed the course in history 403. There were 389 such students.

5. For Prognosis in Chemistry.--There are two elementary courses in chemistry. They are chemistry 401 and 411. Chemistry 401 is taken by the students who have enrolled in chemistry for the first time, while chemistry 411 is for those who have had a course in high-school chemistry or its equivalent.

The subjects for the prognoses in these two courses consisted of all the students in the colleges of Engineering and Agriculture who had taken the intelligence, mathematics, and reading tests and either chemistry 401 or 411. There were 343 such subjects in chemistry 411 and 181 in chemistry 401.

6. To summarize section D, then, we have:

a. A general prognosis of 241 students in the college of Education and 100 students in the college of Arts.

b. For the language prognosis we have 402 students in the colleges of Arts, Commerce, and Education who had taken the Freshman Week Language Test and had taken either French, Spanish, German, or Latin 401.

c. The prognosis of mathematics 431 was based on a
group of 287 subjects in the colleges of Engineering and Agriculture who had taken the intelligence, reading, and mathematics tests and mathematics 431.

d. The prognosis in history concerned the 288 students in Arts, Commerce, and Education who had taken the Freshman Week History Test and history 403.

e. The prognosis in chemistry concerned the students in the College of Agriculture and College of Engineering who had taken the intelligence test and the Freshman Week reading and mathematics tests and Chemistry 411 or 401. There were 343 of the chemistry 411 students and 161 chemistry 401 students.

D. The Treatment of the Data.—The correlation method or technique was the chief method employed in this study to ascertain the relationship of college success, i.e. academic grades, and the other criteria (intelligence or previous training in reading, mathematics, history, and language test scores).

It was explaining in a previous section that all tests were scored on the basis of raw scores. These raw scores were then interpolated into percentile scores, and the percentile scores were put into the permanent files of the statistics bureau.

1. Percentile Codes and Standard Scholarship Rates.—
As a matter of convenience and to facilitate the plotting of correlations all the percentile scores or ranks on all tests were in turn interpolated into code scores. The percentiles were arbitrarily grouped into step intervals of six, as this size interval conveniently fit into the Toops Correlation Chart. The sheets provide for eighteen intervals or steps. There were 16 steps: 0-5 percentiles = step 0; 6-11 step 1, etc.

The point-hour ratio and the marks received in particular courses were accepted as the criteria of success in the different prognoses.

A brief summary of the grading system and point-hour ratio scheme that is employed by the Ohio State University, as explained in Form 3121, the Ohio State University rules regarding the grading system, point value for grades etc., will be given. The grades, meanings of the grades, and points given by the university are as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Meaning</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Excellent</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>Good</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>Average</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Poor</td>
<td>1 point</td>
</tr>
<tr>
<td>E</td>
<td>Failure</td>
<td>0</td>
</tr>
<tr>
<td>Inc</td>
<td>Incomplete</td>
<td>0</td>
</tr>
</tbody>
</table>

It is to be understood that the points assigned to each letter grade are for each hour of work receiving that grade. To illustrate: A grade of A in a 5-hour course is allotted 20 points, etc. A further illustration
concerning credit hours, grades, and points taken from the source cited above is as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Number</th>
<th>Credit Hours</th>
<th>Grade</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>401</td>
<td>5</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>French</td>
<td>401</td>
<td>5</td>
<td>D</td>
<td>5</td>
</tr>
<tr>
<td>English</td>
<td>401</td>
<td>5</td>
<td>C</td>
<td>10</td>
</tr>
<tr>
<td>Hygiene</td>
<td>400</td>
<td>1</td>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>Military Science</td>
<td>401</td>
<td>1</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>Physical Education</td>
<td>401</td>
<td>1</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>18</strong></td>
<td></td>
<td></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

The point-hour ratio is the ratio existing between the number of hours carried and the number of points credit received. The point-hour ratio for the quarter's work cited above would then be \( \frac{42}{18} \), or 2.34.

The actual point-hour ratios were not derived. The grades were obtained, however, and point values calculated. The number of hours carried and number of points credited were totaled. Instead of the usual process of dividing the total number of points by the total number of hours carried to obtain the point-hour ratio, a standard scholarship rate was determined by means of statistical tables (Edgerton, Harold A.: A Table for Finding Point-Hour Ratios and Standard Scholarship Rates. Ohio College Association Bulletin No. 43). This table provides for point-hour ratio values from 0, the lowest possible point-
hour ratio, which means failure in all work undertaken, to 4, the highest point-hour ratio possible, which means a grade of A in all work undertaken.

The size of the grouping interval is .25 points. Consequently these standard scholarship rates range from 0 to 16. This is also a convenient range for plotting on the correlation sheet used.

The point-hour ratio or standard scholarship rate was used only in the general prognosis. In the prognosis for the various subjects the grades received in class A, B, C, D, or E were used.

2. The Solving of the Correlations

a. The simple or zero-order correlation coefficients. --For the general prognosis the zero-order intercorrelations were computed for all of the tests and criteria.

Point-hour ratio was correlated with intelligence, O.S.U. reading, history, mathematics, language, and Freshman Week reading; intelligence with O.S.U. reading, history, mathematics, language, and Freshman Week reading; O.S.U. reading with history, mathematics, language, and Freshman Week reading; history with mathematics, language, and Freshman Week reading; mathematics with language and Freshman Week reading; and language with Freshman Week reading. Thus we have all the intercorrelations between the various
tests and criteria used in the general prognosis.

For the specific prognoses the following correlations were made:

1. For language the scores made by each subject on the Freshman Week language test was correlated with the grade that he received in the 401 language (French, Spanish, German, or Latin) that he had finished.

2. For mathematics, the correlation coefficients were computed between grades received in 431 mathematics and scores in both Freshman Week reading and Freshman Week mathematics.

3. For history the relationship between the grades received in 403 history and scores in intelligence, history, and language was ascertained.

4. For chemistry correlations were computed for intelligence, mathematics, and Freshman Week reading and 401 chemistry; also the correlations for these same tests and chemistry 411.

b. The coefficients of multiple correlation were next computed to find out the best possible prediction of success in the College of Education.

The multiple correlation coefficients were not computed for the various subjects of the College of Education, for the program of subjects elected in that college was quite diverse; hence the number of subjects enrolled in the different courses would have been too small to attach
any reliability to the statistical results obtained. It is to be recalled that the general prognosis involving 247 subjects in the College of Education involves a population sufficiently large to attach statistical significance to it. Likewise the labor involved in solving the numerous multiple correlations would be quite in excess of the results obtained on small population.

Neither were the multiple correlation coefficients computed for the prognoses in the specific subjects. The labor involved and the few tests or criteria entering into these prognoses and interrelationships of the various tests indicate that perhaps the multiple correlation coefficients would not be sufficiently raised over the zero-order coefficients to justify the time and labor.

The multiple correlations were computed by the Doolittle method. The treatment of the data is summarized as follows:

1. Percentile scores were transcribed into coded scores by step values of six. There were sixteen such code steps.
2. Grade points and hours were reduced to standard scholarship rates. The interval was .25 point. There were sixteen standard scholarship rates.
3. For the general prognosis in the College of Education all zero-order correlations were found between the
various test scores and standard scholarship rates, and the intercorrelations between the various tests used in this prognosis were obtained.

4. Simple or zero-order correlation coefficients were solved to find the relationship between test scores and grades received in the various courses prognosed.

5. Multiple correlations were computed to find the best possible general prognosis in the College of Education by means of the various tests used.
CHAPTER IV
The Reliability of the Data

The intelligence test is quite long and is very satisfactorily reliable for most purposes of prediction. The reliability in this test is usually determined by giving alternate forms as explained in the section on administration of tests. The results of alternate forms are correlated to ascertain the reliability. The coefficient of reliability obtained by this method is .95, which is significantly above the required .90 demanded by most research workers.

There were no alternate forms of the Freshman Week tests; hence the odd-evens technique was employed to ascertain the reliability of these tests.

The procedure for determining the reliability of each of the previous-preparation tests (reading, language, history, and mathematics) was identical; hence the procedure will be discussed collectively for all four of these tests.

The procedure was as follows:
A random sampling of 200 cases was taken for each of the tests.

The scores for the odd-numbered items were totaled, as were the scores for the even-numbered items for each paper. Each paper then had an odds and an evens score.
These scores were plotted on a Toops Correlation Chart, and the correlation was obtained between the two halves (odds-evens) of the test.

The correlation coefficients were computed by the Pearson products moment formula.

The raw correlation for the halves of the tests together with their probable errors follow:

<table>
<thead>
<tr>
<th>Test</th>
<th>Cases</th>
<th>rh</th>
<th>rx</th>
<th>Range</th>
<th>Range</th>
<th>sigma</th>
<th>sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math.</td>
<td>200</td>
<td>72</td>
<td>88</td>
<td>0-27</td>
<td>0-29</td>
<td>12.96</td>
<td>10.02</td>
</tr>
<tr>
<td>Hist.</td>
<td>200</td>
<td>96</td>
<td>98</td>
<td>15-86</td>
<td>18-89</td>
<td>57.98</td>
<td>58.66</td>
</tr>
<tr>
<td>Lang.</td>
<td>200</td>
<td>84</td>
<td>92</td>
<td>4-39</td>
<td>4-39</td>
<td>21.36</td>
<td>21.26</td>
</tr>
<tr>
<td>Read.</td>
<td>200</td>
<td>73</td>
<td>84</td>
<td>4-29</td>
<td>4-27</td>
<td>15.9</td>
<td>14.06</td>
</tr>
</tbody>
</table>

A brief explanation of some of the notations used above may be necessary. rh is the correlation obtained by correlating the odds-evens items of the various tests. These sets of scores give the reliability coefficient for one-half the test.

The correlation for the whole test (rx) is found by substituting N = 2 in Spearman's formula and then calculating the reliability of the whole test by the formula

\[ rx = \frac{2rh}{1+rh} \]  
(Garrett: Statistics in Psychology and Education, p. 271).

Most authorities demand a reliability coefficient of a test to be at least .90 and as two of the previous-preparation tests, mathematics and reading, do not quite measure up to that standard, it would be well to know what it is necessary to do to these tests to raise the relia-
bility to at least the desired .90.

Two courses are left open: (1) we can lengthen the test until the desired reliability is obtained, or (2) we can repeat the test and its duplicate twice and average the results (Garrett: Statistics in Psychology and Education, p. 269). Since there are no duplicates for these tests, the only recourse left is to lengthen the test.

\[ rx = \frac{N_r}{1 + (N-1)r} \]

If then we want to find out how much to increase the length of the test to bring the reliability up to the required reliability of .90 by the above formula we find that the history and language tests already meet the requirement and that the mathematics test and the reading test will need to be lengthened.

For reading the formula will read:

\[ .90 = \frac{.84N}{1 + .84N + .84} = 1.7 \]

For mathematics the formula will be:

\[ .90 = \frac{.88N}{1 + .88N + .88} = 1.22 \]

This means that the reading test would need to be made at least 1.7 times its present length and the mathematics test would need to be at least 1.22 times its present length to insure a reliability of .90. The language
and history tests would not need to be lengthened.

The correlation charts which show the scattergrams and computations of the correlations are inserted.
CHAPTER V

General Prognosis of Academic Success as Indicated by Marks

It will be recalled that in Chapter II it was stated that the only criterion of success that would be considered in this study was that which was indicated by course grades. These grades were the first-quarter grades only.

There are two reasons for considering only first-quarter grades. They are: first, the amount of labor involved in collecting the data, and second, different investigations have shown exceptionally high coefficients of correlation to exist between the first-quarter or semester's marks and the marks received during successive quarters or semesters. One of the most clean-cut and comprehensive researches of this type is that of Edgerton in which he computed correlation coefficients between the first quarter and each succeeding quarter's work. His correlation between the first and second quarters' marks was 80; between the first and second combined and the third ; and so on till the correlation between the cumulative marks of the first eleven quarters with the last quarter was .
All of these correlations are significantly higher than those that have been obtained by the criteria used in this research or any similar research.

It is probably sufficient to say that of the criteria as yet used, the first quarter's marks are the best single predictive agent; hence the most important thing is to find a criterion that will satisfactorily predict first-quarter marks.

The correlations computed for this prognosis are given below.

A. The zero-order correlation coefficients computed for this study, as well as the subjects used in the study, have previously been suggested. Briefly restated, however, we have as subjects all of the students in the College of Education who took the university intelligence test, the Freshman Week tests, and completed a quarter's work in the university. The number of such students was 241.

The test scores were obtained immediately after the Freshman Week procedures, and as soon as the first-quarter marks were available (January 1930), reports of all the students were obtained from the Registrar's office.

The percentile ranks of the students in the various tests were transcribed into codes of 6-percentile intervals. The grades and hours carried were transcribed into standard scholarship rates.
All the possible zero-order intercorrelations were computed for all the tests.

Point-hour ratios, i.e. standard scholarship rates, were correlated with each of the tests. The various correlations for each were as follows: point-hour ratio with intelligence .46 P.E. ±0.0345; with O.S.U. reading .41 P.E. ±0.0366; with Freshman Week reading .42 P.E. ±0.0359; with mathematics .33 P.E. ±0.0391; with language .44 P.E. ±0.0351; with history .45 P.E. ±0.0347.

On the basis of these correlation coefficients it may be stated that so far as general prognoses are concerned, one of these tests, with the exception of mathematics, whose correlation with point-hour ratio is much lower than the rest, is almost equally as good as another as a predictive agent. The university intelligence test is slightly higher than any of the others (.46) and thus bears out the majority of other researches, especially Wood's cited in Chapter II, that the intelligence test is probably the best single predictive agent of college success. It likewise confirms a number of the researches in the degree of prediction. The Iowa Placement Examination studies tend to dispute these findings; however, their findings are based on a battery of placement tests and not on any single examination.

As to the value of a correlation coefficient of .45
or thereabouts it may be said that it is not very significantly high. McCall (How to Measure in Education) has arbitrarily grouped the correlation coefficients into three classes. Those which range in size from 0 to .4 are considered low; those from .4 to .7 as significant and those from .7 to 1 are high. On the basis of this classification the findings in this research would be termed "substantial but low."

It should be borne in mind too that the predictable value of correlation coefficients of this size is quite low. For a correlation coefficient of .45 it is but 10.7 per cent better than guess.

A table showing errors of prediction based on correlation coefficients worked out by Kelley and quoted from McCall: How to Measure in Education, (p. 394) follows:

<table>
<thead>
<tr>
<th>r</th>
<th>Error</th>
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<tbody>
<tr>
<td>.00</td>
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</tr>
<tr>
<td>.10</td>
<td>.995</td>
</tr>
<tr>
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<td>.9539</td>
</tr>
<tr>
<td>.40</td>
<td>.9165</td>
</tr>
<tr>
<td>.50</td>
<td>.8660</td>
</tr>
<tr>
<td>.60</td>
<td>.8000</td>
</tr>
<tr>
<td>.70</td>
<td>.7141</td>
</tr>
<tr>
<td>.80</td>
<td>.6000</td>
</tr>
<tr>
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<td>.5268</td>
</tr>
<tr>
<td>.90</td>
<td>.4359</td>
</tr>
<tr>
<td>.95</td>
<td>.3122</td>
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<td>.97</td>
<td>.2431</td>
</tr>
<tr>
<td>.99</td>
<td>.1411</td>
</tr>
</tbody>
</table>

This is often called the coefficient of alienation and is obtained by the formula $\sqrt{1 - r^2}$. 
A more inclusive and perhaps useful table than that of McCall is found on page 52 of The Work of the College Entrance Examination Board, 1901-1925. It is very similar to McCall's table with the exception that the percentages of perfect prediction are given instead of the errors of prediction. Also the percentages of determining factors measured for each correlation are given. The table follows:

<table>
<thead>
<tr>
<th>Coef. of Perfect Corr.</th>
<th>% of Perfect Predict.</th>
<th>% of Determining Factors Measured</th>
<th>Coef. of Perfect Corr.</th>
<th>% of Determining Factors Measured</th>
<th>% of Determining Factors Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>100.0</td>
<td>100.0</td>
<td>.50</td>
<td>13.4</td>
<td>36.6</td>
</tr>
<tr>
<td>.95</td>
<td>68.8</td>
<td>73.3</td>
<td>.45</td>
<td>10.7</td>
<td>33.5</td>
</tr>
<tr>
<td>.90</td>
<td>56.4</td>
<td>67.4</td>
<td>.40</td>
<td>8.3</td>
<td>30.4</td>
</tr>
<tr>
<td>.85</td>
<td>47.3</td>
<td>61.7</td>
<td>.35</td>
<td>6.3</td>
<td>27.2</td>
</tr>
<tr>
<td>.80</td>
<td>40.0</td>
<td>57.1</td>
<td>.30</td>
<td>4.6</td>
<td>23.9</td>
</tr>
<tr>
<td>.75</td>
<td>33.9</td>
<td>53.1</td>
<td>.25</td>
<td>3.2</td>
<td>20.5</td>
</tr>
<tr>
<td>.70</td>
<td>28.6</td>
<td>49.5</td>
<td>.20</td>
<td>2.0</td>
<td>16.9</td>
</tr>
<tr>
<td>.65</td>
<td>24.0</td>
<td>46.1</td>
<td>.15</td>
<td>1.1</td>
<td>13.2</td>
</tr>
<tr>
<td>.60</td>
<td>20.0</td>
<td>42.9</td>
<td>.10</td>
<td>0.5</td>
<td>9.1</td>
</tr>
<tr>
<td>.55</td>
<td>16.5</td>
<td>39.7</td>
<td>.05</td>
<td>0.1</td>
<td>4.8</td>
</tr>
<tr>
<td>.50</td>
<td>13.4</td>
<td>36.6</td>
<td>.00</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

From this table we may conclude as before that the percentage of perfect prediction from our best single test (r .45 or thereabouts) is but about 10.7. This finding is not startling, however, in view of the fact that only 33.5 per cent of the determining factors were measured.

The coefficients of correlation existing between the various tests and the criterion (point-hour ratio) are the validities of the different tests.
The validity of a test is indicated by the coefficient of correlation obtained between the test scores and the criterion.

"Validity," says McCall (p.195), "is the most fundamental characteristic of a test." And further, "Validity may be defined as the correspondence between the ability measured by the test and ability as otherwise objectively defined and measured." Also: "When a test really measures what it purports to measure and consistently measures this same thing throughout the entire range of the test, it has validity as a test."

The validity of the various tests used in this research, if it can be said that they purport to forecast academic success, is indicated by the correlation coefficients previously given. The significance of these correlations depends not merely upon the size of the coefficients, but also upon the types of materials from which they were derived. Some of the important factors covered are the size of the populations considered, the central tendencies, the dispersions, and the probable errors. This information is given in the following table. The code value is given and is the same for all tests. The same code was used for standard scholarship rates, as was explained in Chapter III.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00</td>
<td>96-100</td>
<td>16</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>241</td>
</tr>
<tr>
<td>3.75-3.99</td>
<td>90-95</td>
<td>15</td>
<td>3</td>
<td>18</td>
<td>12</td>
<td>8</td>
<td>7</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>3.50-3.74</td>
<td>84-89</td>
<td>14</td>
<td>6</td>
<td>12</td>
<td>11</td>
<td>8</td>
<td>5</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>3.25-3.49</td>
<td>78-83</td>
<td>13</td>
<td>9</td>
<td>14</td>
<td>11</td>
<td>5</td>
<td>3</td>
<td>17</td>
<td>15</td>
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<tr>
<td>3.00-3.24</td>
<td>72-77</td>
<td>12</td>
<td>9</td>
<td>13</td>
<td>17</td>
<td>5</td>
<td>16</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>2.75-2.99</td>
<td>66-71</td>
<td>11</td>
<td>19</td>
<td>14</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>2.50-2.74</td>
<td>60-65</td>
<td>10</td>
<td>25</td>
<td>15</td>
<td>7</td>
<td>20</td>
<td>13</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>2.25-2.49</td>
<td>54-59</td>
<td>9</td>
<td>33</td>
<td>23</td>
<td>21</td>
<td>12</td>
<td>9</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>2.00-2.24</td>
<td>48-53</td>
<td>8</td>
<td>38</td>
<td>11</td>
<td>18</td>
<td>12</td>
<td>16</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>1.75-1.99</td>
<td>42-47</td>
<td>7</td>
<td>22</td>
<td>16</td>
<td>20</td>
<td>20</td>
<td>14</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>1.50-1.74</td>
<td>36-40</td>
<td>6</td>
<td>16</td>
<td>16</td>
<td>10</td>
<td>12</td>
<td>27</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>1.25-1.49</td>
<td>30-35</td>
<td>5</td>
<td>23</td>
<td>18</td>
<td>16</td>
<td>33</td>
<td>15</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>1.00-1.24</td>
<td>24-29</td>
<td>4</td>
<td>21</td>
<td>18</td>
<td>24</td>
<td>5</td>
<td>13</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>.75-.99</td>
<td>18-23</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>18</td>
<td>18</td>
<td>13</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>.50-.74</td>
<td>12-17</td>
<td>2</td>
<td>6</td>
<td>15</td>
<td>7</td>
<td>20</td>
<td>19</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>.25-.49</td>
<td>6-11</td>
<td>1</td>
<td>3</td>
<td>17</td>
<td>22</td>
<td>22</td>
<td>9</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>.00-.24</td>
<td>0-5</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>11</td>
<td>22</td>
<td>26</td>
<td>9</td>
<td>12</td>
</tr>
</tbody>
</table>

Number: 241

Mean Steps: 7.85
Sigma Steps: 3.12

*The code for P.H.R. is the standard scholarship rate.
Both the sigmas and the means of the above test are given in step values. They may, however, be interpolated into percentiles. This would render them more understandable. The formula for interpolating step means into means for percentiles is \[ M = I \cdot M' + F_o \]

Likewise the sigmas can be interpolated into percentile values for the test scores and P.H.R.'s by the formula \[ \text{sigma} = I \cdot \text{sigma}' \]

\[ M = \text{Mean percentile} \quad M' = \text{Mean step value} \]
\[ I = \text{Interval (grouping)} \quad F_o = \text{Face value of zero step} \]
\[ \text{sigma} = \text{sigma percentile} \quad \text{sigma}' = \text{sigma step value} \]

The value of \( I \) for P.H.R. is .25; for each of the tests the value of \( I \) is 6.

The \( F_o \) (face value of the zero step) for P.H.R. is .125; the zero step is 0-.25; for the tests the zero or first interval is 0-5 and the \( F_o \) of the interval is 2.5.

The formulae for the percentile means and sigmas are respectively:

\[
\begin{align*}
P.H.R. & \\
M &= .25 (M') + .125 \\
\text{sigma} &= .25 \text{sigma}'
\end{align*}
\]

\[
\begin{align*}
\text{Tests} & \\
M &= 6 (M') + 2.5 \\
\text{sigma} &= 6 \text{sigma}'
\end{align*}
\]

The percentile means and sigmas then become:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean %ile</td>
<td>2.09</td>
<td>51.04</td>
<td>46.12</td>
<td>39.94</td>
<td>43.9</td>
<td>52.54</td>
<td>48.7</td>
</tr>
<tr>
<td>Sigma &quot;</td>
<td>.78</td>
<td>27.18</td>
<td>27.18</td>
<td>26.58</td>
<td>27.48</td>
<td>27.36</td>
<td>23.62</td>
</tr>
</tbody>
</table>

This shows that in most cases the mean is near the
50th percentile of the distribution; also that the sigmas are sufficiently large to insure a satisfactory sampling.

The following table shows the correlation coefficients between each of the separate tests and the criterion (P.H.R.).

<table>
<thead>
<tr>
<th>Test</th>
<th>r</th>
<th>P.E.</th>
<th>M</th>
<th>sigma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-hour</td>
<td>.46</td>
<td>.0343</td>
<td>8.09</td>
<td>4.53</td>
</tr>
<tr>
<td>Ratio Intel.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O.S.U.Read.</td>
<td>.41</td>
<td>.0366</td>
<td>7.27</td>
<td>4.53</td>
</tr>
<tr>
<td>F.W. Read.</td>
<td>.42</td>
<td>.0359</td>
<td>6.24</td>
<td>4.43</td>
</tr>
<tr>
<td>Math.</td>
<td>.33</td>
<td>.0391</td>
<td>6.9</td>
<td>4.58</td>
</tr>
<tr>
<td>Lang.</td>
<td>.44</td>
<td>.0351</td>
<td>8.34</td>
<td>4.56</td>
</tr>
<tr>
<td>Hist.</td>
<td>.45</td>
<td>.0347</td>
<td>7.7</td>
<td>4.77</td>
</tr>
</tbody>
</table>

Point-hour ratio mean 7.85; sigma 3.12

Means and sigmas are in step values.

The intercorrelations were likewise computed. The various intercorrelation coefficients were as follows:


These coefficients of correlation obtained by these intercorrelations ranged from .83 to .31. The
highest correlation coefficient among the intercorrelations exists between the intelligence and O.S.U. reading tests. This is not unusual, for it was previously explained that the reading test was part of the intelligence test.

Generally speaking, however, the coefficients of correlation of the various intercorrelations are about the same as the correlation between each of the tests and the criterion (point-hour ratio).

Since the intercorrelations are high as they are, they indicate that the same factors, whatever they are, have been covered to about the same extent by each of the tests.

Lists of the distributions together with the means and sigmas have already been given, so they can be omitted here. A table showing the various intercorrelations of the tests follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P.H.R.</td>
<td>.46</td>
<td>.41</td>
<td>.42</td>
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<td>.45</td>
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<td>Intel.</td>
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<td>.43</td>
<td>.32</td>
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<td>O.S.U.read.</td>
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<td>.83</td>
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<td>.25</td>
<td>.46</td>
<td>.53</td>
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<tr>
<td>F.W.read.</td>
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<td>.43</td>
<td>.39</td>
<td>.43</td>
<td>.38</td>
<td>.31</td>
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<tr>
<td>Math.</td>
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<td>.32</td>
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<td>.43</td>
<td>.35</td>
<td>.34</td>
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</tr>
<tr>
<td>Lang.</td>
<td>.44</td>
<td>.57</td>
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<td>.35</td>
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<tr>
<td>Hist.</td>
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<td></td>
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B. The Multiple Correlations.—As has been stated, the simple-order correlations were significant but not at all high. In fact even the highest, the estimates of
### Rectangular

<table>
<thead>
<tr>
<th>Job Name</th>
<th>Step</th>
<th>Solution of Equation</th>
</tr>
</thead>
<tbody>
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### Reading

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### N

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### O

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<tbody>
<tr>
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### C

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<tr>
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</tbody>
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### T

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</table>

### M

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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

### H

<table>
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<tr>
<th>N</th>
<th>E</th>
<th>O</th>
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<tbody>
<tr>
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### Product

<table>
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<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Job Analysis

- Step 1: Calculate the dimensions of the rectangle
- Step 2: Check the area and perimeter
- Step 3: Verify the solution

### Formula

- Area = length \times width
- Perimeter = 2 \times (length + width)
college success based upon test scores, is as much as 88 to 89 per cent pure guess. This means really very low prediction.

The technique of multiple correlation was employed to find out the most predictive combinations of the tests used, and the weights, coefficients of regression, or as they are commonly termed, the Beta weights were determined by the Doolittle method of solving multiple equations.

The variables were considered in the order that they have been treated thus far in the study: intelligence (1), O.S.U. reading (2), F.W. reading (3), mathematics (4), language (5), and history (6). The criterion score was of course the point-hour ratio.

When all the tests were combined, the multiple correlation, or $R$ as it is usually written, was .587763, or carried to the second significant place, .59.

The following table gives the criterion correlations and the Beta weights attached to each:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Criterion Correlations</th>
<th>Beta Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intelligence</td>
<td>.4597</td>
<td>.069759</td>
</tr>
<tr>
<td>2. O.S.U. reading</td>
<td>.4139</td>
<td>.040661</td>
</tr>
<tr>
<td>3. F.W. reading</td>
<td>.4175</td>
<td>.190870</td>
</tr>
<tr>
<td>4. Mathematics</td>
<td>.3308</td>
<td>.068113</td>
</tr>
<tr>
<td>5. Language</td>
<td>.4368</td>
<td>.186886</td>
</tr>
<tr>
<td>6. History</td>
<td>.4505</td>
<td>.229791</td>
</tr>
</tbody>
</table>

From this particular combination of variables it appears that the weights attached to the different
variables are, in order of descending importance: history, F.W. reading, language, intelligence, mathematics, and O.S.U. reading.

In this grouping it is evident that history is the most valuable test for the prediction. This is not surprising, however, in view of the fact that the simple correlation between history and point-hour ratio was one of the highest simple correlations.

All of the possible multiple correlations were not found, but five of them were computed, not by the process of eliminating the least predictive test first, the next second, etc., but in the order 6, 5, 4, 3, 2, and this would leave then only the simple correlation between intelligence and P.H.R. or .46 P.E. + .0343 previously stated.

When test 6 (history) was eliminated from the group the Beta weights became:

<table>
<thead>
<tr>
<th>Test</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>.152605</td>
</tr>
<tr>
<td>O.S.U. reading</td>
<td>.096344</td>
</tr>
<tr>
<td>F.W. reading</td>
<td>.098832</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.108007</td>
</tr>
<tr>
<td>Language</td>
<td>.193613</td>
</tr>
</tbody>
</table>

The resultant multiple correlation coefficient was .557901 or .56. Thus the elimination of the history test noticeably lowered the R.

This grouping placed the importance of the tests as indicated by their weights in the following order

The next grouping of tests gave the following result:

<table>
<thead>
<tr>
<th>Test</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>.247175</td>
</tr>
<tr>
<td>O.S.U. reading</td>
<td>.091511</td>
</tr>
<tr>
<td>F.W. reading</td>
<td>.217568</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.136182</td>
</tr>
</tbody>
</table>

The multiple correlation was .536082 or .54. Thus the elimination of language from the group lowered the correlation 2 points.

The respective importance of the tests in this grouping was intelligence, F.W. reading, mathematics, and O.S.U. reading.

The fourth multiple eliminated mathematics from the group. The following weights were assigned:

<table>
<thead>
<tr>
<th>Test</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>.279641</td>
</tr>
<tr>
<td>O.S.U. reading</td>
<td>.079566</td>
</tr>
<tr>
<td>F.W. reading</td>
<td>.266347</td>
</tr>
</tbody>
</table>

The multiple R was .522191 or .52. This was but one point lower than when mathematics was included. The order of importance of tests in this grouping was intelligence, F.W. reading, and O.S.U. reading. The final grouping was the intelligence test and O.S.U. reading. They were weighted as follows:
Thus it appears that as a predictive measure the intelligence test is roughly three and one-third times as valuable as the reading section of that test alone. The multiple correlation in this case was .465805, or 46.

The following table summarizes the findings stated above with respect to the multiple correlation coefficients obtained.

<table>
<thead>
<tr>
<th>Tests</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read. Read.</td>
<td></td>
</tr>
<tr>
<td>(2) Intel. O.S.U. F.W. Math. Lang.</td>
<td>.56</td>
</tr>
<tr>
<td>Read. Read.</td>
<td></td>
</tr>
<tr>
<td>(3) Intel. O.S.U. F.W. Math.</td>
<td>.54</td>
</tr>
<tr>
<td>Read. Read.</td>
<td></td>
</tr>
<tr>
<td>(4) Intel. O.S.U. F.W.</td>
<td>.52</td>
</tr>
<tr>
<td>Read. Read.</td>
<td></td>
</tr>
<tr>
<td>(5) Intel. O.S.U.</td>
<td>.46</td>
</tr>
</tbody>
</table>

The weights for the above tests in the same order were as follows:

<table>
<thead>
<tr>
<th>O.S.U.</th>
<th>F.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel.</td>
<td>Reading</td>
</tr>
<tr>
<td>(1) .089759</td>
<td>.040661</td>
</tr>
<tr>
<td>(2) .152605</td>
<td>.096344</td>
</tr>
<tr>
<td>(3) .247175</td>
<td>.091511</td>
</tr>
<tr>
<td>(4) .279641</td>
<td>.079566</td>
</tr>
<tr>
<td>(5) .369955</td>
<td>.108635</td>
</tr>
</tbody>
</table>
The general prognosis of a group of 100 Arts College students will be stated briefly.

The independent correlations between point-hour ratios and test scores were somewhat higher for all the tests than they were in the College of Education. The tests maintained practically the same ranking as to prognostic value in both colleges.

The correlations between point-hour ratio and the different tests were: point-hour ratio with intelligence .57 P.E. ± .0415, with O.S.U. reading .57 P.E. ± .0415, with mathematics .38 P.E. ± .0567, with language .56 P.E. ± .0415, with history .45 P.E. ± .0536.


The intercorrelations for this group of tests appear in the following table:
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P.H.R.</td>
<td>.57</td>
<td>.57</td>
<td>.38</td>
<td>.56</td>
<td>.45</td>
<td></td>
</tr>
<tr>
<td>Intel.</td>
<td>.57</td>
<td>.84</td>
<td>.62</td>
<td>.74</td>
<td>.62</td>
<td></td>
</tr>
<tr>
<td>O.S.U.read</td>
<td>.57</td>
<td>.62</td>
<td>.51</td>
<td>.71</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td>Math.</td>
<td>.38</td>
<td>.62</td>
<td>.51</td>
<td>.46</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>Lang.</td>
<td>.56</td>
<td>.74</td>
<td>.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hist.</td>
<td>.45</td>
<td>.62</td>
<td>.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The highest multiple correlation obtained for this group of data was .626. This correlation was obtained by the use of all the tests.

As the procedure was identical with that of the Education group, only the tables will be given.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Criterion Correlation</th>
<th>Weight</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Five Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Intelligence</td>
<td>.57</td>
<td>.1047</td>
<td></td>
</tr>
<tr>
<td>2. O.S.U.reading</td>
<td>.57</td>
<td>.2205</td>
<td></td>
</tr>
<tr>
<td>3. Mathematics</td>
<td>.38</td>
<td>.0358</td>
<td></td>
</tr>
<tr>
<td>4. Language</td>
<td>.56</td>
<td>.2488</td>
<td></td>
</tr>
<tr>
<td>5. History</td>
<td>.45</td>
<td>.1190</td>
<td>.626</td>
</tr>
<tr>
<td><strong>Four Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Intelligence</td>
<td>.57</td>
<td>.1527</td>
<td></td>
</tr>
<tr>
<td>2. O.S.U.reading</td>
<td>.57</td>
<td>.2335</td>
<td></td>
</tr>
<tr>
<td>3. Mathematics</td>
<td>.38</td>
<td>.0467</td>
<td></td>
</tr>
<tr>
<td>4. Language</td>
<td>.56</td>
<td>.2597</td>
<td>.6191</td>
</tr>
<tr>
<td><strong>Three Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Intelligence</td>
<td>.57</td>
<td>.2781</td>
<td></td>
</tr>
<tr>
<td>2. O.S.U.reading</td>
<td>.57</td>
<td>.3116</td>
<td></td>
</tr>
<tr>
<td>3. Mathematics</td>
<td>.38</td>
<td>.0486</td>
<td>.5955</td>
</tr>
<tr>
<td><strong>Two Tests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Intelligence</td>
<td>.57</td>
<td>.3098</td>
<td>.5943</td>
</tr>
<tr>
<td>2. O.S.U.reading</td>
<td>.57</td>
<td>.3098</td>
<td>.5943</td>
</tr>
<tr>
<td><strong>One Test or Simple r</strong></td>
<td></td>
<td></td>
<td>.57</td>
</tr>
<tr>
<td>1. Intelligence</td>
<td>.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The above results grouped as in the previous section become:

<table>
<thead>
<tr>
<th></th>
<th>Test</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Read.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Read.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Intel.</td>
<td>O.S.U.</td>
<td></td>
<td>Math.</td>
<td></td>
<td>.5955</td>
</tr>
<tr>
<td></td>
<td>Read.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Intel.</td>
<td>O.S.U.</td>
<td></td>
<td></td>
<td></td>
<td>.5943</td>
</tr>
<tr>
<td></td>
<td>Read.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Intel.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.57</td>
</tr>
</tbody>
</table>

The weights summarized are:

<table>
<thead>
<tr>
<th>Intelligence</th>
<th>O.S.U. Reading</th>
<th>Mathematics</th>
<th>Language</th>
<th>History</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.1047</td>
<td>.2205</td>
<td>.0358</td>
<td>.2488</td>
</tr>
<tr>
<td>2</td>
<td>.1527</td>
<td>.2335</td>
<td>.0467</td>
<td>.2597</td>
</tr>
<tr>
<td>3</td>
<td>.2781</td>
<td>.3116</td>
<td>.0486</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.3098</td>
<td>.3098</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When all the tests were used, the language and O.S.U. reading tests merited the greatest weights. History, however, was not weighted so heavily in the Arts group as it was in the Education group.

The mathematics test seemed to be the least predictive of any of the tests in either study.

**Summary of Chapter**

1. The simple or zero-order correlation coefficients were computed for the point-hour ratio with each of the tests.

2. The intercorrelations of all the tests were computed.
3. The correlations between the criterion and the tests for the Education group ranged from .33 P.E. ± .0391 for mathematics to .45 P.E. ± .0343 for intelligence. The average correlation between criterion and tests was about .42 P.E. ± .0358. These correlations are significant, as they are more than four times the P.E.

4. For the Arts College groups the correlation coefficients between the criterion and the test scores were somewhat higher but retained the same relative positions with the exception of the history coefficient, which did not increase in this group. The coefficients range in size from .38 P.E. ± .0567 to .57 P.E. ± .0415 with an average of about .52 P.E. ± .0506. These coefficients too are significant, as they are more than four times their probable errors. They are, however, not high.

5. The intercorrelations between the tests in the College of Education ranged from .25 P.E. ± .0404 to .83 P.E. ± .0135.

For the Arts College the intercorrelations were very much higher. The range was from .38 P.E. ± .0567 to .84 P.E. ± .0187 with an average of .56 P.E. ± .0432. These coefficients are rather high for intercorrelations and indicate a considerable overlapping of the subject matter of the tests.
6. The results obtained in these prognoises do not differ markedly from those reported by other investigators. Few investigators have shown tests to be of high general prognostic value.
CHAPTER VI
Prognosis in Language

This particular prognosis is not all the work of the writer. The data were collected and correlation coefficients were computed under the direction of Dr. L. C. Fressey. It is as yet an unpublished research. The materials, however, are a part of the present problem or series of problems, and this phase, language prognosis, is quoted here.

As was stated in Chapter III, the tests from which the present data were collected was the Freshman Week Language Test. The test was previously analyzed but will be briefly summarized here. The materials were selected on the basis of frequency of occurrence in eight different foreign language textbooks in four different languages. The languages were French, Spanish, German, and Latin. Numerous English test- and handbooks were also analyzed. From these analyses 260 different concepts were identified, but this group was deleted to the 86 most frequently occurring of the group.

These 86 concepts were submitted to a group of twelve language professors, who divided them into two groups. Forty-five concepts were considered basic to
introductory courses, and the other forty-one for advanced work.

These 86 concepts were embodied in a test 40 items in length. Each item contained one or more of the concepts.

As one of the phases of the Freshman Week program this test was given to all of the entering freshmen in the Arts, Commerce, and Education colleges.

At the end of the autumn quarter the grades were obtained for all of the students who had enrolled in French 401, German 401, Spanish 401, or Latin 401. The 401 courses are first-quarter courses. The students whose marks were obtained were then the freshmen who were enrolled for the first time, or at least for the first quarter, in language.

The grades were obtained for all of the students who took a 401 language course and also who had taken the language test at the beginning of the quarter. There were some of course who had taken the language tests, but who had not taken a 401 language course. Likewise there were many who had taken a language but who had not taken the test, as the test was not given to students other than in the three colleges listed above. There were, however, 402 students who had taken both the test and a 401 language course.

For these students the coefficient of correlation
between the test score and grades received in the courses was .81 P.E. \( \pm .0122 \).

The correlations for the separate courses, French, German, Spanish, and Latin, were not computed.

This correlation coefficient of .81 is very high. It will be recalled too that the reliability of the language test as indicated by the correlation coefficient of the two halves of the test was .92. Since this is a language test and is a test which purports to measure ability in language, it has a validity coefficient of .81.

Other studies, especially the Iowa Placement studies, show correlation coefficients between specific tests and grades in subjects to be markedly higher than correlations between intelligence test scores and grades in specific subjects.

The highest correlation coefficients reported by Stoddard in 1928 were .56 and .61 between physics training and French training tests and grades received in physics and French respectively. Perin reports a correlation coefficient of .54 obtained between the University of Texas Psychological Examination (intelligence) and grades received in English.

The following table shows a distribution of the grades received by students whose scores fall in the different percentiles.
Dr. L. C. Pressey has arbitrarily grouped the students into thirteen groups containing approximately an even number of subjects. The groups also show the range of percentiles for each group. The table follows:

<table>
<thead>
<tr>
<th>Section</th>
<th>No. of Students</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Range of Percentiles on Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>22</td>
<td>8</td>
<td>2</td>
<td></td>
<td></td>
<td>93-100</td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td>9</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td></td>
<td>85-92</td>
</tr>
<tr>
<td>3</td>
<td>35</td>
<td>9</td>
<td>14</td>
<td>12</td>
<td></td>
<td></td>
<td>75-84</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>2</td>
<td>10</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>67-74</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>1</td>
<td>10</td>
<td>14</td>
<td>4</td>
<td>1</td>
<td>58-66</td>
</tr>
<tr>
<td>6</td>
<td>32</td>
<td>6</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>50-57</td>
</tr>
<tr>
<td>7</td>
<td>35</td>
<td>17</td>
<td>10</td>
<td>6</td>
<td></td>
<td></td>
<td>43-49</td>
</tr>
<tr>
<td>8</td>
<td>36</td>
<td>16</td>
<td>14</td>
<td>6</td>
<td></td>
<td></td>
<td>35-42</td>
</tr>
<tr>
<td>9</td>
<td>30</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td></td>
<td></td>
<td>27-34</td>
</tr>
<tr>
<td>10</td>
<td>35</td>
<td>8</td>
<td>10</td>
<td>17</td>
<td></td>
<td></td>
<td>20-26</td>
</tr>
<tr>
<td>11</td>
<td>28</td>
<td>1</td>
<td>10</td>
<td>17</td>
<td></td>
<td></td>
<td>14-19</td>
</tr>
<tr>
<td>12</td>
<td>28</td>
<td>11</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td>5-13</td>
</tr>
<tr>
<td>13</td>
<td>28</td>
<td>6</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td>1-4</td>
</tr>
</tbody>
</table>

It is noted by inspection of the table that no student in the upper eight percentiles received a grade of less than C and only two students received C's. It is also interesting to note that no student below the 50th percentile received a grade of above C and that the students whose percentile ranks were below 14 received grades of D and E only.

On the basis of tests whose results are as valid and reliable as these one can foretell with a degree of accuracy what success students of given scores on the test will have in the language courses.

The question of the desirability of sectioning
classes on the basis of test results is as yet unsettled. The usual basis employed in sectioning, however, has been the intelligence test, which as has already been stated is not a good predictive agent of success in specific courses. Tharp (Sectioning Classes in Romance Languages, Modern Language Jr., 2, XII, Nov. 1927) has reported that his sectioned classes, high, middle, and low sections, have gained markedly over his non-sectioned classes. The sections were made on the basis of the Iowa Placement Test in modern language.

The indication is, however, that classes in language might profitably be sectioned on the basis of ability.

Conclusions

1. The language test used in this prognosis consisted of a list of 40 items containing the 83 most frequently used concepts found in analyses of language and English textbooks.

2. The test has a reliability coefficient of .92. The reliability was obtained by correlating the two halves of the test.

3. The prognosis was based upon the test records and grades received by 402 first-quarter freshmen who were enrolled in French, German, Spanish, or Latin 401.

4. The coefficient of correlation obtained between
the test score and grade received in a language course was \( .81 \pm .0122 \). This coefficient indicates the validity of the test and is very significant.

5. The correlation obtained between test and grades is much higher than those reported in other studies.

6. The prognosis indicates that the students in language might well be sectioned at the beginning of the course on the basis of test results.

7. As is usual in most statistical studies, the extremes are quite definitely set off. That is, students with very high test scores receive excellent grades; those with low scores receive poor grades; but the grades of those whose scores range in the middle percentiles 25-75 are not so clearly differentiated.
CHAPTER VII
Prognosis in Mathematics

The prognosis in mathematics, as was stated in a previous chapter, concerned a group of 287 students in the College of Engineering who had taken the Freshman Week reading and mathematics tests and had completed the course in mathematics 431 (college algebra).

The materials for the test were selected on the basis of extensive researches and analyses of several textbooks of chemistry and physics to ascertain what mathematical concepts and skills were required for courses in those branches.

On the basis of these findings the Freshman Week Mathematics Test was devised. It consisted of two parts. Part 1 consisted of two sections, one of which involved twelve problems in arithmetic. The problems were addition and division of common fractions, division of decimals, percentage, and expressions of relationship between numbers. The second section consisted of a group of problems involving algebraic skills. These problems were addition, subtraction, multiplication, and division of whole numbers and fractions, simplification of terms, finding the values of unknowns, substitution of known values, and
proportions.

Part 2 was made up of necessary mathematical concepts. There were three sections in part 2. Section 1 consisted of units of measure, both English and metric; section 2 of understanding of equations; and section three of the technical vocabulary needed in mathematics.

During Freshman Week the test was given to the freshmen who had enrolled in all the colleges.

At the close of the autumn quarter the grades for all of the students in the colleges of Agriculture and Engineering who had enrolled in mathematics 431 were secured. These students also had taken the Freshman Week Reading Test, which it will be recalled contained sections on the understanding of certain mathematical procedures. There were 287 students who had taken both the Freshman Week tests and the course in mathematics 431.

The correlation between the mathematics and Freshman Week Reading tests for the group of College of Education students involved in the general prognosis was found to be .43 P.E. ±0.0355. This shows a significant overlapping of subject matter of the two tests. The correlation coefficient between these same two tests for this particular group was not computed.

The Toops Special Correlation Sheet which provides for the division of the students into five groups or classes
based upon percentile ranks was used in this prognosis. The groups are I, as represented by percentile ranks 96-100; group II, percentiles 76-95; group III, percentiles 26-75; group IV, percentiles 6-25; and group V, percentiles 1-5.

This distribution is, of course, according to the so-called normal probability curve. Since grades received in college courses conform more or less to this curve, it is probably as good a method as any for division into groups for computing correlation coefficients. The grouping error is no doubt large, but the regular chart was used as a check-up on the accuracy of the correlation obtained. There was a difference of but one or two points obtained by the different sheets. Hence it was concluded that for the purpose of prediction one sheet was as good as the other. The special sheet, since it is divided into but five groups or divisions, as are the grades in the various subjects, is much easier to tabulate and compute the correlations from than are the regular sheets.

Few correlations differentiate clearly between groups throughout the range of distributions; therefore this particular grouping might present some advantages.

The correlation coefficients obtained between the mathematics test and grade received in mathematics 431 was .47 P.E. .0314. The correlation coefficient between Freshman Week reading and mathematics 431 was .39 P.E. ±.0327.
Neither of these correlations is high, but they are significant, as they are well over four times their probable errors.

Two factors probably contribute to keeping the correlation coefficients low. These factors are the system of grading in the Department of Mathematics and the distributions of students selected for this prognosis.

It will be noticed by an inspection of the following tables that the number of grades of E, D, and B is approximately equal, while those of C and A are much higher and lower respectively. There were in the mathematics course 55 E's, 58 D's, 86 C's, 51 B's, and but 30 A's. This is of course quite different from the normal distribution of grades.

On the other hand, as was stated above, the sampling of students used in this prognosis does not represent a normal sampling of all the students who took the tests. According to the mathematics test results the group was markedly superior in mathematics, and according to the reading results the group was considerably above the average. The sampling could not be helped, nor for that matter the grading system, for all students in the two colleges mentioned who took the Freshman Week reading and mathematics tests and Mathematics 431 were included. If all the students who took the tests had enrolled in the course in mathematics, the prediction would no doubt have been much
higher.

The tables showing the various frequencies in the different groups follow:

Distribution of Percentile Scores in Mathematics Test

<table>
<thead>
<tr>
<th>Class and Percentiles</th>
<th>V 1-5</th>
<th>IV 6-25</th>
<th>III 26-75</th>
<th>II 76-95</th>
<th>I 96-100</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math.Distribution</td>
<td>2</td>
<td>3</td>
<td>73</td>
<td>150</td>
<td>59</td>
<td>287</td>
</tr>
<tr>
<td>Normal</td>
<td>14</td>
<td>58</td>
<td>143</td>
<td>58</td>
<td>14</td>
<td>287</td>
</tr>
</tbody>
</table>

Distribution of Grades in Mathematics

<table>
<thead>
<tr>
<th>Math. Distribution</th>
<th>E 55</th>
<th>D 58</th>
<th>C 90</th>
<th>B 52</th>
<th>A 32</th>
<th>Total 287</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>14</td>
<td>58</td>
<td>143</td>
<td>58</td>
<td>14</td>
<td>287</td>
</tr>
</tbody>
</table>

A double-entry table showing both mathematics classes and grades received in the course follows:

Mathematics Test Classes

<table>
<thead>
<tr>
<th>Grades</th>
<th>V 0</th>
<th>IV 0</th>
<th>III 1</th>
<th>II 14</th>
<th>I 7</th>
<th>Total 32</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>14</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>31</td>
<td>16</td>
<td>52</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>54</td>
<td>18</td>
<td>90</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>31</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>3</td>
<td>30</td>
<td>20</td>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>Totals</td>
<td>2</td>
<td>3</td>
<td>73</td>
<td>150</td>
<td>59</td>
<td>287</td>
</tr>
</tbody>
</table>

Distribution by Classes in Reading Test

<table>
<thead>
<tr>
<th>Reading Distribution</th>
<th>V 5</th>
<th>IV 3</th>
<th>III 73</th>
<th>II 150</th>
<th>I 59</th>
<th>Total 282</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>14</td>
<td>58</td>
<td>143</td>
<td>58</td>
<td>14</td>
<td>282</td>
</tr>
</tbody>
</table>

This would indicate that the group was decidedly superior in reading.
The grades received by the above groups are given in the following table:

<table>
<thead>
<tr>
<th></th>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Distribution</td>
<td>55</td>
<td>58</td>
<td>88</td>
<td>51</td>
<td>30</td>
<td>282</td>
</tr>
<tr>
<td>Normal</td>
<td>14</td>
<td>58</td>
<td>143</td>
<td>58</td>
<td>14</td>
<td>282</td>
</tr>
</tbody>
</table>

A double-entry table which combines the two tables above follows:

<table>
<thead>
<tr>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>15</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>3</td>
<td>21</td>
<td>17</td>
<td>10</td>
<td>51</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>3</td>
<td>47</td>
<td>26</td>
<td>11</td>
<td>88</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>8</td>
<td>23</td>
<td>20</td>
<td>2</td>
<td>58</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>2</td>
<td>27</td>
<td>17</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>3</td>
<td>23</td>
<td>126</td>
<td>95</td>
<td>35</td>
<td>282</td>
</tr>
</tbody>
</table>

It will be noticed that in the group who took the mathematics test there were 287 students, while the group in reading consisted of 5 less students, or 282.

The reliability of the mathematics test was .88 P.E. +.0108. The test is not bad, then, so far as reliability is concerned, but its validity is not high (.47 P.E. +.0314).

In order to get a more significant prediction it will probably be necessary to get a more representative sampling of all those who took the mathematics test. This, it will be remembered, was one of the least predictive of those used in the general prognosis.
The reliability of the reading test is .84 P.E. $\pm .0140$. The test should be lengthened to be made more reliable, but it is doubtful whether if it were satisfactorily reliable the prediction of mathematics grades would be significantly higher. The reading test was one of the important tests in the general prognosis.

A further study was made showing the correlation between reading ability and grade in mathematics 400. This course is made up of students who are failures or potential failures that have been eliminated from the other freshman mathematics courses. There were 61 in this group.

The distribution of classes in reading was much better in this group than in the mathematics 431 group. The following table gives a distribution of classes and grades received.

<table>
<thead>
<tr>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td></td>
<td>11</td>
<td>4</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>10</td>
<td></td>
<td>3</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>9</td>
<td>4</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Totals</td>
<td>0</td>
<td>15</td>
<td>31</td>
<td>14</td>
<td>1</td>
<td>61</td>
</tr>
</tbody>
</table>

The distribution of grades received, however, was much skewed downward.

The correlation obtained was .28 P.E. $\pm .0802$. This is of course quite low and is of little predictive value.
Summary of Mathematics Prognosis

1. The tests used in this prediction were the mathematics and reading tests used in the Freshman Week.

2. The students involved were 287 students who took the mathematics and reading tests and mathematics 431. There were 282 students in the group who took the mathematics and reading tests and mathematics 431.

3. The Toops Special (5-class) Correlation Sheet was used to find the correlation coefficients between test scores and grades received in the mathematics course.

4. The range of sampling was not representative for either the mathematics or the reading test. Both groups were much above the average.

5. The grades received in mathematics 431 did not at all conform to an expected normal curve. There were approximately the same number of grades of E, D, and B. There were fewer C's than were expected and more A's.

6. Both the reading and mathematics tests were slightly less reliable than they should be.

7. The validity of the mathematics test found by the correlation of the test result with the criterion (mathematics grade) was .47 P.E. ± .0314. For reading it was .39 P.E. ± .0327.

8. These results are about on a par with those reported by Stoddard with respect to the predictive
efficiency of the Iowa Placement Test in Mathematics. He reports .46 for mathematics aptitude, .51 for mathematics training, and .51 for aptitude and training combined.

9. The correlation between Freshman Week reading and subfreshman mathematics 400 was but .28 P.E. ± .0802.
CHAPTER VIII
The Prognosis in History

This prognosis, like that for language, is not all the writer's work, but as it is a part of the present study, it is quoted here. The data were collected and correlations computed under the direction of Dr. L. C. Pressey, and the results are as yet unpublished. The results of her study are quoted here and some additions of the nature of further correlations were made by the writer.

The test, as was stated in Chapter III, was composed of two parts. Part 1 involved the understanding of 160 historical concepts, persons, and dates. Part 2 consisted of data dealing with the geographical background for history.

These materials, it was previously stated, were selected on the basis of importance. The criterion of importance was that of frequency of mention in textbooks and other sources. Numerous very elaborate analyses of textbooks were involved.

During the Freshman Week program the history test, along with other tests, was given to the freshmen entering the colleges of Applied Optics, Arts, Commerce, and Education. The other tests common to these colleges were
intelligence, mathematics, and language. The Applied Optics group is a very small group, and their results were ignored so far as this prognosis is concerned.

For Mrs. Pressey's study, she selected as subjects all of the students in the colleges of Arts, Commerce, and Education who had a percentile score in the history test and a grade in history 403 (a course in freshman history). There were 388 such students.

As another phase of the same study the writer used as subjects all the students in the colleges of Arts, Commerce, and Education who had records not only in history tests and grades, but also in intelligence and language.

The groups of students in both phases of the research were the same except of course that when more than one variable is involved, the size of the group diminishes. The number of cases used in finding the correlation between intelligence score and grades was 388, or all of those who were used in the first prognosis. The number used for finding the relationship between language scores and grades in history was 263. These students had scores in intelligence, history, and language and grades in history 403.

The treatment of the data in this study was very similar to that followed in the language prognosis. The grades were obtained at the close of the autumn quarter,
and the correlation coefficient was computed between the grades in history and the percentile scores on the Freshman Week test. The coefficient of correlation thus obtained was .70 P.E. ±.0199. This correlation is quite high. It is much higher in fact than any of those obtained in the general prognosis, although it will be recalled that the history test was one of the most important tests in the battery used for general prognosis. Not only did it have one of the highest correlation coefficients with general point-hour ratio alone, but also it was assigned the greatest weight of any single test in the multiple correlation when all tests were used.

This group was divided into thirteen sections, as was the language group, each of which contained approximately the same number of students. An inspection of the following table clearly indicates that the majority of grades A and B were received by the students scoring highest on the previous-preparation test in history. Likewise it will be noted that no grades of A or B were received by students scoring below the 27th percentile in the previous-preparation test. This type of test corresponds to what Stoddard calls the training test as opposed to aptitude. There were in the Iowa tests, however, no history tests.

The correlation obtained between course grades and test scores on this test, however, runs considerably above
the average of the correlations obtained for the placement
tests.

### History Sections as Based on
#### Percentiles in History Test

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of Students</th>
<th>Grades</th>
<th>Range of Percentiles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>27</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>31</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>31</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>31</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>33</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>29</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>28</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>12</td>
<td>26</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>31</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>

388

For this particular group of students then we can say that the validity of the history test is .70.

The test at present is being revised and new sections concerning individuals and events are being added.

The other phase of the study, as was mentioned previously in this chapter, concerns all of these same students for whom complete records could be obtained. That is, intelligence, language, and history percentiles and grades in history 403.

The intercorrelations between these three tests were found in the general prognosis study to be: intelligence and language .57 P.E. + .0494, intelligence and history
.55 P.E. ± .0303, language and history .36 P.E. ± .0379.
We have, then, significant correlations indicative of some amount of overlapping of abilities measured by these tests.

The correlation coefficients between intelligence score and grades in history as well as that for language score and grades in history were computed in the special correlation chart that was used in the mathematics prognosis.

The Pressey cases were also plotted on this type of sheet (five groupings instead of several) and verified the correlation of .70 found on the other sheet.

The correlation coefficient between intelligence-test percentiles (classes) and history 403 grades was .51 P.E. ± .0253. This is the highest prognosis that had been attained between intelligence and course grades up to this point in the research. It is quite comparable to that reported by Perrin and quoted by Stoddard referred to heretofore. Their correlation between intelligence and English grades was .54.

The distributions of intelligence and also the distribution of history grades conformed much more closely to a normal distribution than was the case with the mathematics group.

Tables showing these distributions follow:
Intelligence %ile Classes

<table>
<thead>
<tr>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>6-25</td>
<td>26-75</td>
<td>76-95</td>
<td>96-100</td>
<td>371</td>
</tr>
<tr>
<td>History Distribution</td>
<td>15</td>
<td>70</td>
<td>193</td>
<td>77</td>
<td>16</td>
</tr>
<tr>
<td>Normal</td>
<td>17</td>
<td>74</td>
<td>189</td>
<td>74</td>
<td>17</td>
</tr>
</tbody>
</table>

This table shows an excellent sampling of students according to ability.

Grades in History 403

<table>
<thead>
<tr>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>History Distribution</td>
<td>47</td>
<td>70</td>
<td>135</td>
<td>90</td>
<td>29</td>
</tr>
<tr>
<td>Normal</td>
<td>17</td>
<td>74</td>
<td>189</td>
<td>74</td>
<td>17</td>
</tr>
</tbody>
</table>

This distribution is not so good, but it is as good as one could reasonably expect from grades coming in independently from different instructors.

Following is a double-entry table showing distributions of both history grades and intelligence.

Intelligence Percentile Classes

<table>
<thead>
<tr>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>1</td>
<td>12</td>
<td>10</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>5</td>
<td>49</td>
<td>27</td>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>20</td>
<td>75</td>
<td>38</td>
<td>1</td>
<td>135</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>25</td>
<td>39</td>
<td>1</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
<td>19</td>
<td>18</td>
<td>1</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Totals</td>
<td>15</td>
<td>70</td>
<td>193</td>
<td>77</td>
<td>16</td>
<td>371</td>
</tr>
</tbody>
</table>

It is evident from an inspection of the table that in general those of highest intelligence-test scores received the better grades in history, as but one individual below class III received a grade of A, and but six students in that same group received B's. On the other hand the
same thing can be said with respect to low grades. But one student above class III received an E, and but two received grades of D. The middle groups are as is usual not clearly differentiated but tend to group similarly in both intelligence groups and history grades.

The correlation coefficient between language scores and history grades was .42 P.E.±.0358.

Here again we find a satisfactory distribution of scores with respect to showing on the language test but the history grades do not conform to any such normal distribution; hence the low correlation between the language scores and grades in history 403.

Tables showing distribution of grades and classes follow:

<table>
<thead>
<tr>
<th>Classes of Language-Test Percentiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Language Distribution</td>
</tr>
<tr>
<td>Normal</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grades in History</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Language Distribution</td>
</tr>
<tr>
<td>Normal</td>
</tr>
</tbody>
</table>

Here again we find a flattening out of the distribution.

A double-entry table showing both grades in history and percentile classes in language follows:
<table>
<thead>
<tr>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>8</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>5</td>
<td>35</td>
<td>22</td>
<td>3</td>
<td>67</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>17</td>
<td>54</td>
<td>21</td>
<td>2</td>
<td>94</td>
</tr>
<tr>
<td>D</td>
<td>3</td>
<td>15</td>
<td>24</td>
<td>4</td>
<td>0</td>
<td>46</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>Totals</td>
<td>11</td>
<td>49</td>
<td>136</td>
<td>60</td>
<td>7</td>
<td>263</td>
</tr>
</tbody>
</table>

This table gives an indication of the relationship between language scores and history grades. It is not so clean-cut as either the relationships indicated in the tables showing history test scores and history grades or intelligence percentiles and history grades.

The correlation is significant, however, and in the absence of a better measure would give a prediction better than mere guess.

Summary of Prognosis in History

1. The tests used in this prediction were the intelligence tests and the language and history tests that were given during Freshman Week.

2. The students were those from the colleges of Arts, Commerce, and Education. Of these students those who had scores on the history test and grades in 403 history numbered 388. This was the total number of students for whom records were available; 371 students had scores in the intelligence and history tests and grades in history 403; and 263 students had scores in the intelligence,
history, and language tests and grades in history 403.

3. For the history prognosis with the history test the regular Toops Correlation Sheet was used and verified by the special sheet. The correlation coefficient existing between history test scores and history grades was .70 P.E. ± .0199.

4. For the prognosis of history by intelligence and language test scores the correlation coefficients were .51 P.E. ± .0253 and .42 P.E. ± .0358 respectively. These correlations are not high, but they are significant.

5. The distributions in the three tests were very satisfactory; the distributions of grades were much nearer normal than was the case of the mathematics grades.

6. The reliability of the history test has previously been reported as .98 P.E. ± .0019. The validity coefficient of the test is .70 P.E. ± .0199.

7. The history test can then be regarded as both reliable and valid.
CHAPTER IX
Prognosis in Chemistry

This prognosis, which is the last of the series of prognoses for specific courses, is different from those previously reported in that each of the other prognoses reported was based on at least one test that was designed for that particular field. The most predictive agent for language was the language test; for mathematics (although but a poor prognosis was made in that field) was the mathematics test; for history it was the history test. For this phase of the study, we do not have any test that was designed specifically for chemistry.

The tests involved in the chemistry prognosis were the intelligence test and the Freshman Week reading, mathematics, and English tests. These tests have already been described in connection with the different prognoses, hence it will not be necessary to describe them again here.

This selection of tests was made, as these were the only tests given in the colleges (Engineering and Agriculture) where a chemistry prognosis was attempted.

The students involved in the study were the men in the college of Agriculture and Engineering who had taken all of the tests mentioned above and had completed
the course in chemistry 401. There were 73 students in this group. The students from the same colleges who had complete records in the intelligence, Freshman Week reading and mathematics tests and grades in chemistry 401 were selected for this study. There were 181 men students in this group.

The third group consisted of all of the students who had scores in the intelligence and Freshman Week reading and mathematics tests and grades in chemistry 411. There were 343 in this group.

The other tests, language and history, were not involved in the prognosis of chemistry, for those tests were not given to the Agriculture and Engineering students.

A brief explanation of the two courses 401 and 411 may be necessary. Both of these courses are freshman courses, but 401 is strictly a beginner's course, whereas 411 is designed for those who have had chemistry in high school.

The tests were all given during Freshman Week previous to the opening of the autumn quarter. The tests were scored and results interpreted into percentiles as has previously been described.

As soon as the autumn quarter grades were available, they were obtained and the coefficients of correlation were computed to find out if any reliable prognosis
could be made on the basis of the showing in the tests.

The correlation between the intelligence-test scores for the 343 students who completed chemistry 411 was .35 P.E. ±.0325. This correlation is low, but it compares favorably with the average of correlations between intelligence and specific subjects that have been reported by different writers. It is somewhat lower than the correlation obtained between the intelligence-test scores and general prognosis. This, however, is characteristic of intelligence tests, as usually they will make more accurate general than specific predictions.

The correlations were plotted on the special correlation chart.

The selection of subjects so far as intelligence classes is concerned was very satisfactory, but the chemistry grades all seem to be skewed upward. There were but few E's, but many D's, B's, and A's.

The distributions for both intelligence and grades will be given after the report of correlations between the reading and mathematics tests with chemistry grades.

The correlation coefficient between the Freshman Week reading test scores and chemistry 411 grades was found to be .44 P.E. ±.0295. This correlation is not high, but it is significant. A possible reason for the size of the correlation is that the reading test contains
paragraphs dealing with chemistry and other sciences and also sections on the reading and understanding of formulae that are used in science.

The distributions of reading-test scores, while it is not as good as that for intelligence, is fairly satisfactory. The trend of the distribution seems to be skewed toward the higher percentiles. The distribution of grades is of course the same as that just given for intelligence and chemistry 411.

The correlation coefficients computed between the mathematics-test scores and grades in chemistry 411 was .48 P.E. ± .0282. This coefficient is very similar to that of reading. It is almost exactly the same (one point difference) as the correlation between mathematics-test scores and grades in mathematics 431. That is to say that the mathematics test predicts both mathematics and chemistry grades to the same degree. All of the students in the two prognoses were not the same, but many of the same students were used in both predictions.

Many of the mathematical concepts embodied in the mathematics tests were derived from analyses of textbooks in science.

The tables showing the various distributions of tests used to predict chemistry follow:
<table>
<thead>
<tr>
<th>Classes of Test Files</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>9</td>
<td>69</td>
<td>186</td>
<td>62</td>
<td>17</td>
<td>343</td>
</tr>
<tr>
<td>Reading, F.W.</td>
<td>9</td>
<td>40</td>
<td>157</td>
<td>106</td>
<td>31</td>
<td>343</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
<td>28</td>
<td>137</td>
<td>135</td>
<td>42</td>
<td>343</td>
</tr>
<tr>
<td>Normal Distribution</td>
<td>17</td>
<td>69</td>
<td>171</td>
<td>69</td>
<td>17</td>
<td>343</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemistry 41l Grades</th>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry Distribution</td>
<td>11</td>
<td>37</td>
<td>163</td>
<td>92</td>
<td>40</td>
<td>343</td>
</tr>
<tr>
<td>Normal Distribution</td>
<td>17</td>
<td>69</td>
<td>171</td>
<td>69</td>
<td>17</td>
<td>343</td>
</tr>
</tbody>
</table>

A double-entry table showing distributions of test scores in intelligence and grades in chemistry 41l follows:

<table>
<thead>
<tr>
<th>Intelligence Percentile Classes</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td>18</td>
<td>13</td>
<td>9</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>12</td>
<td>50</td>
<td>25</td>
<td>5</td>
<td>92</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>36</td>
<td>97</td>
<td>23</td>
<td>3</td>
<td>163</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>15</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Totals</td>
<td>9</td>
<td>69</td>
<td>186</td>
<td>62</td>
<td>17</td>
<td>343</td>
</tr>
</tbody>
</table>

Following is a table showing distribution of reading-test scores and grades in chemistry 41l:

<table>
<thead>
<tr>
<th>Reading Percentile Classes</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>13</td>
<td>9</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>12</td>
<td>50</td>
<td>25</td>
<td>5</td>
<td>92</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>36</td>
<td>97</td>
<td>23</td>
<td>3</td>
<td>163</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>15</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>37</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>69</td>
<td>186</td>
<td>62</td>
<td>17</td>
<td>343</td>
</tr>
</tbody>
</table>
Following is a table showing distribution of test scores in mathematics and grades in chemistry 411:

<table>
<thead>
<tr>
<th>Mathematics Percentile Classes</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>19</td>
<td>15</td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>24</td>
<td>50</td>
<td>16</td>
<td></td>
<td>92</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
<td>80</td>
<td>59</td>
<td>11</td>
<td></td>
<td>163</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>22</td>
<td>5</td>
<td></td>
<td></td>
<td>37</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Totals</td>
<td>28</td>
<td>137</td>
<td>135</td>
<td>42</td>
<td></td>
<td>343</td>
</tr>
</tbody>
</table>

The prediction of 401 chemistry by the same three tests as those just used for chemistry 411 follows:

The correlation coefficient between intelligence and chemistry 401 grade was .41 P.E. ± .0418. Between reading scores and chemistry 401 it was .53 P.E. ± .0561. Between mathematics score and chemistry 401 grade it was .47 P.E. ± .0391.

Of these three coefficients the intelligence and reading are higher and mathematics remained practically the same as with chemistry 401.

The distributions of the scores in intelligence and reading were quite satisfactory, while those of mathematics were somewhat skewed upward. This upward trend of mathematics scores in all of the tests indicates that for engineering students at any rate the mathematics test was too easy.
The distributions for the three tests follow:

<table>
<thead>
<tr>
<th>Test Percentile Classes</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligence</td>
<td>11</td>
<td>26</td>
<td>104</td>
<td>36</td>
<td>4</td>
<td>181</td>
</tr>
<tr>
<td>F.W. Reading</td>
<td>8</td>
<td>28</td>
<td>97</td>
<td>38</td>
<td>10</td>
<td>181</td>
</tr>
<tr>
<td>Mathematics</td>
<td>9</td>
<td>19</td>
<td>82</td>
<td>59</td>
<td>12</td>
<td>181</td>
</tr>
</tbody>
</table>

Following is the distribution of grades in chemistry 401:

<table>
<thead>
<tr>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>21</td>
<td>71</td>
<td>51</td>
<td>26</td>
<td>181</td>
</tr>
</tbody>
</table>

This distribution shows the same tendency toward an upward skewness of grades, and is opposite to the tendency for mathematics 431.

Double-entry tables showing the relationship between test scores and grades follow:

<table>
<thead>
<tr>
<th>Intelligence Percentile Classes</th>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>12</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>1</td>
<td>31</td>
<td>14</td>
<td>4</td>
<td></td>
<td>51</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>1</td>
<td>12</td>
<td>51</td>
<td>7</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>4</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>11</td>
<td>26</td>
<td>104</td>
<td>36</td>
<td>4</td>
<td>181</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reading Percentile Classes</th>
<th>Grades</th>
<th>V</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>1</td>
<td>9</td>
<td>12</td>
<td>4</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>2</td>
<td>32</td>
<td>11</td>
<td>6</td>
<td></td>
<td>51</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>2</td>
<td>12</td>
<td>44</td>
<td>13</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>8</td>
<td>28</td>
<td>97</td>
<td>38</td>
<td>10</td>
<td>181</td>
</tr>
<tr>
<td>Chemistry Grades</td>
<td>Mathematics Percentile Classes</td>
<td>V</td>
<td>IV</td>
<td>III</td>
<td>II</td>
<td>I</td>
<td>Total</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------</td>
<td>---</td>
<td>----</td>
<td>-----</td>
<td>----</td>
<td>---</td>
<td>-------</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>5</td>
<td>16</td>
<td>5</td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>5</td>
<td></td>
<td>51</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>11</td>
<td>34</td>
<td>2</td>
<td>19</td>
<td>2</td>
<td>71</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>2</td>
<td>11</td>
<td>3</td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>9</td>
<td>19</td>
<td>82</td>
<td>59</td>
<td>12</td>
<td>181</td>
</tr>
</tbody>
</table>

The above tables are interpreted in the same manner as are previous similar tables, so they will not be discussed here.

The third group of data analyzed with respect to chemistry prognoses concerns a group of 73 students who have complete records in the intelligence test, reading, mathematics, and English tests.

The number of cases is small—perhaps too small for reliable predictions. The distribution of grades is much skewed upward. In fact there are but two grades of E and 6 of D.

The correlations between chemistry 401 grades and the scores in the various tests are as follows: chemistry 401 with intelligence .61 P.E. ±.0488, with O.S.U. reading .54 P.E. ±.0552, with mathematics .37 P.E. ±.0672, with F.W. English .39 P.E. ±.0666.

The outstanding difference between this group of findings and that of the previous chemistry prognosis is the very much higher correlation between the intelligence-test score and grade in chemistry 401.
The distribution for the percentile ranks on the test follows. The step values are for percentile ranks grouped by intervals of 6.

<table>
<thead>
<tr>
<th>%ile Step Value</th>
<th>Test</th>
<th>O.S.U.</th>
<th>F.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Intelligence</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Total | 73 | 73 | 73 | 73 | 73 |
Mean  | 54.22 | 54.58 | 62.62 | 68.14 | 48.7 |
sigma | 28.14 | 28.74 | 26.66 | 6.78 | 27.60 |

Distribution of Grades

<table>
<thead>
<tr>
<th></th>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry 401 Distribution</td>
<td>2</td>
<td>6</td>
<td>25</td>
<td>25</td>
<td>14</td>
<td>73</td>
</tr>
<tr>
<td>Normal Distribution</td>
<td>4</td>
<td>15</td>
<td>30</td>
<td>15</td>
<td>4</td>
<td>73</td>
</tr>
</tbody>
</table>

Summary of Chemistry Prognosis

1. This chapter deals with an attempt to prognose chemistry grades by the use of tests other than chemistry tests.

2. The tests used in this prognosis are the uni-
versity intelligence test and the Freshman Week reading, mathematics, and English tests.

3. The men students in the colleges of Agriculture and Engineering who had taken the tests during Freshman Week and who had taken either chemistry 401 or 411 were used as the subjects in the study. Three hundred forty-three students who had taken the intelligence, reading, and mathematics tests and chemistry 411 were the subjects for one phase of the study, 181 students who had taken the same tests and chemistry 401 for another phase, and the 73 students who had taken all of the Freshman Week tests that were given in their colleges for the third.

4. The correlations for the first group, or the students in chemistry 411 were: chemistry 411 with intelligence .35 P.E. ± .0321, with reading .44 P.E. ± .0295, and with mathematics .48 P.E. ± .0282.

For the first chemistry 401 group the correlation of chemistry 401 grade with intelligence was .41 P.E. .0418, with reading .53 P.E. ± .0361, and with mathematics .47 P.E. ± .0391.

For the second chemistry 401 group the correlations between chemistry 401 and intelligence was .61 P.E. ± .0488, O.S.J. reading .20 P.E. ± .0748, F.W. reading .54 ± .0552, mathematics .37 P.E. ± .0672, and English .39 P.E. ± .0666.
5. None of the correlations was very high, but most of them were significant. The reading and mathematics tests consistently ranked above the other tests used for prognosing chemistry. One exception to the above statement occurred in the case of one group of chemistry 401 for which the correlation between chemistry grade and intelligence was higher than that for any other tests.

6. The correlation between intelligence and grade in chemistry is about the same as that reported by Stoddard.
Other investigations concerning the prediction of academic success of college freshmen are reviewed. The literature indicates that the only criterion used for success is that of academic grades. This criterion was also used in the present study. It may be open to numerous criticisms, but after all the point-hour ratio which the freshman can show carries more weight than any other single qualification when it comes to the point whether he shall be allowed to remain in school or asked to withdraw.

In an overwhelming majority of the researches reviewed but a single predictive agent was used. When but one criterion was used, it was most often the intelligence-test score. The chief method used to determine the relationship between test scores and point-hour ratio was that of correlation.

The size of correlation coefficients obtained between intelligence test scores and college grades varies greatly among different tests or between the same tests used in different places or even between the same test used in the same place at different times. The correlation
coefficients between the Army Alpha examination and college grades range in size from .13 to .65. The majority of them cluster between .30 and .50 with an average of about .40 to .45. The Brown University test shows a range of coefficients from .30 to .60. The Thorndike Examination coefficients range from .37 to .65, Thurstone test from .20 to .48, and Ohio State University Psychological Examination from .40 to .65.

These findings may be summarized by saying that in general the correlations obtained between intelligence-test scores and college grades range from .40 to .50 for the better tests. Of the groups of intelligence tests reviewed, the Ohio State Psychological Test and the Thorndike Intelligence Test seem to get the higher correlations most consistently.

The college entrance examination is one of the chief measures for fitness to do college work especially in the eastern colleges. Correlation coefficients between grades on the entrance examination and college grades are reported to be in the .40-.50 range. All who take the examinations are not permitted to enter college. This selective factor would operate to keep the correlations low. Were all applicants admitted to the universities, the validity of these examinations would probably be much higher; as is suggested by the College Entrance Board,
perhaps in the .60-.70 range.

Stoddard reports that the Iowa Placement Examinations (subject-matter) correlate as high as .65 to .75 with academic success.

Combinations of the Thorndike Intelligence Test scores with other criteria (regents' examination and secondary-school marks) gives a multiple correlation of .66 at Columbia University. Using similar data, Odell's correlations were somewhat lower.

The present problem is to determine on the basis of the available criteria (intelligence and subject-matter tests) the best possible predictions of both general and specific college success. General success is interpreted to mean the point-hour ratio or general scholarship, and specific means grades received in the various courses, such as language, history, mathematics, etc.

The materials involved in the study were the Ohio State University Psychological Test (intelligence) and the Freshman Week tests in reading, mathematics, language, history, and English. The tests were administered to the freshmen during Freshman Week.

The method was that of correlating scores received on the tests with point-hour ratios and grades received in certain courses. Both single and multiple correlation techniques were employed.
The reliability of the intelligence test was found by correlating duplicate forms. The reliability of this examination is about .95 or .96. There were no alternate forms of the Freshman Week tests, and their reliabilities were determined by the odds-evens technique.

The following are the reliability coefficients of the Freshman Week tests:

- Reading \( \cdot 84 \text{ P.E. } \pm 0.0140 \)
- Mathematics \( \cdot 88 \text{ P.E. } \pm 0.0108 \)
- Language \( \cdot 92 \text{ P.E. } \pm 0.0104 \)
- History \( \cdot 98 \text{ P.E. } \pm 0.0019 \)

If a minimum reliability of .90 is required for a test, the reading and language test both should be lengthened to increase their reliabilities.

The **General Prognosis**.--The correlations between point-hour ratios and the test scores were as follows:

\[
\begin{array}{ccc}
\text{Intelligence} & r & \text{P.E.} \\
\text{O.S.U. Reading} & .41 & .0366 \\
\text{F.W. Reading} & .42 & .0359 \\
\text{Mathematics} & .33 & .0391 \\
\text{History} & .45 & .0347 \\
\end{array}
\]

None of these correlations is high, but all are significant. Intelligence is the most predictive of the group used here, and mathematics is the least.

The highest multiple correlation obtained in this
prognosis was .5877. All the tests were required to obtain this coefficient.

For a general prognosis, then, it may be said on the basis of the above findings that we do not have a good single predictive agent for general scholarship and furthermore that a combination of all of the tests used did not give as high a prediction as would be desirable.

The above general prognosis is for the College of Education. The Arts prognosis both by individual tests and by a combination of the tests was slightly superior to the Education prognosis.

The Specific Prognoses

1. Prognosis in language was good. The correlation between the language test and grades received in 401 language courses (French, Spanish, German, or Latin) was .81 P.E. ± .0122.

This is an unusually good prediction and suggests that perhaps specific prognoses rather than general prognoses are more nearly possible: hence it may be that instead of general prognoses specific prognoses for specific curricula might prove more valuable than general prognoses for all students.

2. Prognosis in mathematics was made by correlating the grades received in mathematics 431 with the scores received on the Freshman Week reading and mathematics tests.
The correlation existing between mathematics grades and scores on the mathematics test was only .47 P.E. ± .0314. Between mathematics grades and score on the reading test it was .39 P.E. ± .0327.

Both of these correlations were discouragingly low, as it was hoped that the mathematics test at least would be of much higher predictive value.

The low correlation between the mathematics test and the grades in mathematics may be partially explained by the fact that the sampling of grades in the mathematics test resulted in a far from normal distribution.

The mathematics test had been given to all of the freshmen in all colleges, and the percentile norms were based on the scores made by all the freshmen. The group used in making this prognosis was, however, only the men students in the colleges of Agriculture and Engineering who were enrolled in mathematics 431. Hence the sampling had to be confined to that group.

The results of the tests showed this group to be of superior mathematical ability.

One other factor which probably had no small effect on keeping the size of the correlation small was the decided skewness of the grades given in the course. Nothing could be done of course about the selection of grades, for they were simply those given by the department. An idea
of the flatness of the distribution is gained from the following:

<table>
<thead>
<tr>
<th>Mathematics Distribution</th>
<th>E</th>
<th>D</th>
<th>C</th>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>14</td>
<td>58</td>
<td>143</td>
<td>58</td>
<td>14</td>
</tr>
</tbody>
</table>

If there is no more differentiation in grades than appears in this distribution, it will be hard to devise a test that will accurately predict success in mathematics.

3. Prognosis in history fared somewhat better than that in mathematics. The history test was more reliable (.98 P.E. ± .0019) than the mathematics test; also the distribution of test scores of the subjects used in this prognosis was much nearer random or normal distribution than was that of the mathematics group. The distribution of grades in history 403 likewise approached a normal distribution.

The correlation between test scores and grades in history 403 was .70 P.E. ± .0199. It would of course be desirable to have an even higher correlation, but this is a much higher prediction than is obtained in most of the studies reported in the literature. It supports the statement that perhaps specific prognoses rather than general prognoses are likely to be more valid.

There were correlations between intelligence and language test scores and grades in history of .51 P.E.
\(0.0203\) and \(0.42\ P.E.\ \pm 0.0358\) respectively. These correlations are higher than the correlations between intelligence-test scores and point-hour ratios in the general prognosis.

4. Prognosis in chemistry was attempted on the basis of the scores made in several of the tests used during Freshman Week. We had no test in chemistry. Since the reading test contained not only sections of reading on science but also mathematical formulae that are used in science, it was thought that perhaps the test might in a measure predict success of the students in the beginner's courses, chemistry 401 and 411.

Likewise many of the mathematical concepts used in the mathematics test were found in the analyses of science textbooks. It was suspected that perhaps the mathematics test score might predict chemistry success.

The reading and mathematics scores as well as the intelligence-test scores were correlated with the chemistry 411 grades. The correlation between chemistry 411 and intelligence was \(0.35\ P.E.\ \pm 0.0325\). Between chemistry 411 and reading it was \(0.44\ P.E.\ \pm 0.0215\). Between chemistry 411 and mathematics it was \(0.48\ P.E.\ \pm 0.0282\).

These correlations are not high, but they indicate that both the mathematics and the reading tests did to a fair degree predict grades in chemistry 411.
Somewhat higher correlations were obtained between the scores on these same tests and grades in chemistry 401. The correlations were: intelligence .41 P.E. ±.0418, reading .53 P.E. ±.0361, and mathematics .47 P.E. ±.0391.

The distributions of scores for the various tests were fairly representative or normal, but the grades in chemistry were somewhat skewed upward.

It was found, as had been suspected, that there were items of information in both the reading and mathematics tests that proved to be of benefit to the chemistry student.

It is suggested, however, that although a fair prediction was obtained on the basis of these two tests, a much better prediction could be obtained on the basis of a test designed specifically to test chemistry aptitude or training. Such a test, known as a science test, is being constructed in the department at the present time.

Conclusion

This research indicates that the prognosis of academic success of college freshmen has not advanced to any very high degree of certainty. This research and others show that general prognoses, even by means of our best intelligence tests, do not run consistently high. The
usual correlations between academic success range from .30 to .65, but the large majority cluster between .40 and .50. Even though these correlations are not high, they are valuable.

It is perhaps not too much to expect that prognoses should take a trend from the general to the particular. Such prognoses as were obtained in language and in history in this study indicate that it is possible to devise tests dealing with specific subjects that will make a far more accurate prediction of success in the specific fields than general tests will in general fields.
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AUTOBIOGRAPHY

I, Brian Earle Tomlinson, was born at Grenola, Kansas, October 23, 1896. I received my elementary school training in the rural schools of Elk County, Kansas, and my secondary school training at the Grenola High School, Grenola, Kansas. I received my diploma from the Grenola High School in 1915.

During the year 1915-1916, I taught in a rural school in Chautauqua County, Kansas. The succeeding years spent in public school work were as follows: teacher in the grammar grades, Rock Creek Consolidated Schools, Rock Creek, Kansas, 1917-1918; principal of grade school at Hartford, Kansas 1919-1920; principal of Grenola High School, Grenola, Kansas, 1920-1921; superintendent, Clements Consolidated Schools, Clements, Kansas, 1925-1927. My undergraduate work was done at the Kansas State Teachers College, Emporia, Kansas, during the following terms and years: spring 1916; academic year 1916-1917; spring 1918; summer 1919; academic years and summer terms 1923-1924-1925. I received the B. Sc. in Educ. degree from Kansas State Teachers College, in 1925. During the year 1924-1925 I was an assistant in the Psychology Department. During my senior year I was elected to membership in Kappa Delta Pi, national scholastic educational fraternity, and Pi Kappa Delta, national forensic fraternity. The year 1918-1919 was spent in the U. S. Navy.

I began my graduate work during the summer quarter 1927 at The Ohio State University from which I received the Master of Arts degree in 1928. Since 1928 I have been enrolled in The Ohio State University working toward the degree of Doctor of Philosophy.

I was an assistant in the Psychology Department at The
Ohio State University during the year 1927-1928 and since that time have been an instructor in the same department. I was elected to membership in Phi Delta Kappa, honorary educational fraternity, and Alpha Epi Delta, honorary psychological fraternity in 1927 and have since served a year as president of each of the organizations. During the coming year I will be associate professor of psychology and director of the Psychological Clinic at the Kansas State Teachers College, Emporia, Kansas.