Comparative efficiency of certain scholastic aptitude tests in predicting academic success,

Ernest Wilson Mitchell

University of Massachusetts Amherst

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COMPARATIVE EFFICIENCY OF CERTAIN
SCHOLASTIC APTITUDE TESTS IN PREDICTING
ACADEMIC SUCCESS

MITCHELL - 1933
COMPARATIVE EFFICIENCY OF CERTAIN SCHOLASTIC APTITUDE
TESTS IN PREDICTING ACADEMIC SUCCESS

BY

ERNEST WILSON MITCHELL, JR.

THESIS SUBMITTED FOR DEGREE OF MASTER OF SCIENCE

MASSACHUSETTS STATE COLLEGE, AMHERST

JUNE, 1933.
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CHAPTER I
INTRODUCTION

The purpose of this study is to determine the most valid available test for use in predicting the academic success of college freshmen. More definitely this study will attempt to answer the following questions:

1. Which test, (a) the Psychological Examination, (b) the Massachusetts State College Scholastic Aptitude Test, Form Alpha, (c) the Massachusetts State College Scholastic Aptitude Test, Form Beta, is the best indicator for use in prognosticating the academic success of college freshmen?

2. Which type of subject matter will select the highest and lowest average mark quartiles with the greatest accuracy?

3. What is the relationship between the gross and composite test scores and the average marks of the upper and lower ten students?

4. What is the significance of the composite scores on the intelligence tests and the term marks of students "flunking out".

It is not possible for one study to give a complete answer to all of the above questions. Restriction in re-
gard to time alone limits the completeness of some of the questions (question 1). Other limitations also affect the results. The "battery" of tests was administered to three hundred and four students, but nine of these were forced to withdraw before the close of the first term largely because of financial difficulties. The marks used are those obtained by the Class of 1936 during the first and second terms of the 1932-33 academic year. The tests were given to two groups of freshmen, on three consecutive days, by two administrators. Some ten students took one or more of the tests at a later time. Despite these decided limitations the writer hopes that this study may widen the ray of light already cast upon this subject by other investigators.

History of the Mental Testing Movement. If, according to Pintner (1) we trace the influence in psychology and the allied sciences that led to an interest in mental testing, we can distinguish four lines of approach: (a) experimental psychology; (b) study of individual differences; (c) the growth of eugenics; and (d) anthropological measurement.

No attempt to differentiate between each one will be made. The history of mental testing is the history of the work of various outstanding men. Galton, for example, could be classified under any of the four approaches.
A great deal of credit must be given to Wundt who in 1879 opened an experimental psychology laboratory in Leipzig. The establishment of this laboratory stimulated the growth of experimental psychology by transplanting, as it were, the methods and apparatus of physiology and physics into the psychological laboratory. The use of experimental psychology directly caused a recognition of individual differences owing to the fact that the differences between the individual observers acted as disturbing factors.

In the person of Francis Galton (1832-1911) we find a man who was very active in the field of mental measurement or mental testing as we use the terms today. His work in connection with mental measurement grew out of his anthropometric studies. Galton did work on heredity and the nature of mental powers and in order to obtain his data developed the questionnaire method. He also developed the statistical method in order to obtain objective results. Galton has been called by Professor Boring (2) "The father of mental measurement, of individual differences with respect to traits, with Fechner and Charcot of ideational types, the originator of the questionnaire and of the theory of eugenics."

Associated with Galton was Karl Pearson, whose statistical investigations have made his name known throughout the
world. In addition there were such men as Cyril Burt, Carl Spearman, Edwin Boring and G. Udny Yule.

The next man, chronologically, who made significant contributions in the development of mental tests was Hermann Ebbinghaus. It is to him that we owe the nonsense syllable, which is an instrument for measuring associations, immediate memory, etc., and the principle of the completion test.

The work of Alfred Binet (1857-1911) was a very original piece of work and deserves mention here. Binet carried the principles of the laboratory over into the street and the school. From 1904 until 1911, Binet spent his time developing this new method of intelligence measurement which we call the "mental test" scale. His contributions may be summed up as follows:

1. His notion of a study of the individuals' higher capacities.

2. His conception of a scale, a battery of tests arranged and graded according to the average for various chronological levels.

3. The idea of a mental age.

The Binet tests were first introduced into this country by H. H. Goddard, in 1908, who experimented with them at the Vineland Training School, in New Jersey. Another im-
important step in connection with the Binet tests consisted of the work done by L. M. Terman, in the famous Stanford revision with its introduction of the Intelligence Quotient, which made mental testing more quantitative than qualitative.

The work of Cattell in testing college students is too much of a pioneer movement to escape notice. Tests were given to students at Columbia University in 1894. These first tests were largely motor and sensory motor in nature. The mental testing movement owes a large portion of its development in this country, to Cattell and other Columbia men, principal of whom are Robert Woodworth, Pintner, and E. L. Thorndike. They have been dealing mostly, by statistical methods, with individual differences and applications of psychology.

In 1917, the testing movement received an impetus from which it has not yet recovered. A practical need arose for a test that could be administered without the presence of an expert (4). The American Psychological Association constructed the Army Group Examination Alpha which was given to nearly two million soldiers. This test became very popular and opened a new field of mental testing. A great number of group tests were devised, greater promises being made for each one. The Army Group Examination is still
used to a great extent at the present time in spite of more recent tests of the same nature (5).

The most recent development in the field of mental testing is the attempt to predict special capacities, aptitude or abilities. The present tendency is for mental testers not to measure general intelligence for purely scientific reasons but to measure specific abilities in order to predict future achievement for more practical reasons.

Prognosis has been based on the results of various types of tests. For example, one of the most detailed and elaborate studies is reported by Gates (6). School achievement was measured by means of three objective educational tests in grade I to about sixteen in grades III to VIII. Intelligence was measured by the Stanford-Binet and by seven to ten group intelligence tests, both verbal and non-verbal. The correlations of the educational tests with the three types of intelligence tests are as follows: (7).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Binet</th>
<th>Verbal</th>
<th>Non-Verbal</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>.36</td>
<td></td>
<td>.30</td>
</tr>
<tr>
<td>II</td>
<td>.44</td>
<td></td>
<td>.23</td>
</tr>
<tr>
<td>III</td>
<td>.47</td>
<td>.65</td>
<td>.22</td>
</tr>
<tr>
<td>IV</td>
<td>.42</td>
<td>.54</td>
<td>.22</td>
</tr>
<tr>
<td>V</td>
<td>.51</td>
<td>.49</td>
<td>.17</td>
</tr>
</tbody>
</table>
VI  .67  .57  .29
VII  .52  .08
VIII .47  -.15

Burt (8) does not give his results separately for each grade. He reports a correlation of .91 between the Binet tests and school work for 689 children from 7 to 14 years of age. This correlation is extremely high. It is true, however, that in practically every case there exists a positive correlation between intelligence and educational achievement. The most frequent correlations run between .30 and .60. The prognostic value of the above results are based upon general intelligence and are only a few of the many such studies that have been made but that are too numerous to mention here.

The college student has offered the mental tester a fertile field for his investigations. Prediction has been the chief reason for giving these tests but all of the studies have been somewhat concerned with the reliability of the tests. Innumerable coefficients of correlation have been published between intelligence scores and marks in academic work. Possibly, the most widely used test of college level is the Psychological Examination (9). This test is based largely on the capacity of the individual to recall
information or facts learned in the past. MacPhail gives the correlation between the scores obtained on the Psychological Examination and college success as .29. These results are part of a survey, made in 1924, of thirty-four American colleges and universities.

Despite the vast amount of work that has been published regarding the correlation between intelligence test scores and college marks, with a prediction of academic success or failure in view, the credit for developing a test based "essentially on ability to achieve through learning, retaining, recalling and recognizing new material" must go to H. N. Glick and Alfred H. Holway. The scores of this test, given in 1932, to freshmen at the Massachusetts State College gave a correlation coefficient of .488 ± .035 when compared with the average marks. The fact that there is a definite relationship between the ability to learn and success in college is significant and the authors of the test believe that an increase in prognostic efficiency is not unlikely.

Secondary school average marks correlate only .35 (10) with first year marks in college while "College board examination" grades correlate less than .40 (11) with college marks. The coefficient of prognostic efficiency is rather low and practically useless for practical purposes. It is hoped that the results of this study may show some increase
in predictive ability. A test may be low in efficiency in regard to the perfect prediction and yet may be distinctly better than any criteria now in use. The problem resolves itself to this: Which is the best of the available, though yet unsatisfactory, prognosticators of academic success?

This Massachusetts State College Scholastic Aptitude Test, Form Alpha, was supplemented by another test, in the fall of 1933, called Form Beta (12). The Beta test is practically identical in form with Form Alpha, differing only in one particular. The Alpha form contains sense material primarily, while the Beta form is made up of nonsense material; the assumption being that a test measuring ability to learn should not contain any information already known to the individual taking the test. In spite of the fact that the material used in Form Alpha was supposedly unknown it was learned that some material was known to a few subjects. The primary purpose of Form Beta was to correct this difficulty. The extent to which this defect has been remedied will be discussed later (Cf. Chapter IV, p. ).
CHAPTER II
COLLECTION OF DATA

Definition of terms and nomenclature. It seems advisable to state at this point that this study is partially a continuation of previous work done at the Massachusetts State College by A. H. Holway (13); hence, for ease in comparison and to prevent confusion or contradiction through the introduction of different terminology, the present writer has adopted Holway's definitions. A mark received in a single academic course of study is referred to as a term mark and the general average of a student for a completed term, an average mark. An individual score is the score obtained on a single section of a mental test; the sum of the individual scores on a test is called the gross score. The composite score is the combination of two or more gross scores. The term mark is used as the criterion of achievement in a specific course of study. The criterion of academic success is the average mark for the term.

Examination of criteria of academic success. It is necessary to examine the criterion of academic success, namely, average marks, in order to understand some of the limitations connected with them. "The sine qua non of the college is its academic work" (14). In this work the sole criteria of academic achievement are the obtained marks,
hence, it is expedient to investigate the general nature of these standards. It has long been the custom of educational institutions to rate students nominally in order of their academic achievement. The definition of this achievement has been very vague and variable. Each instructor has a different basis of marking. For example, one college instructor found himself quite unable to believe that there could be teachers "intelligent enough to be on a college staff" who would base their marks upon anything but "the actual achievement of the student in the course and subject matter that is being taught to the student by the instructor who is giving the grade." But to one noted professor and prolific writer on various aspects of education this manner of grading is bad; he complains that "it is even wicked because it so often seems to degrade or punish those of inferior abilities and to exalt those whose brilliancy is not of their own making." Another professor bases his marks almost wholly on the effort put forth by the student and on the growth of the student as measured by the difference between his knowledge of the content of the course at the beginning and at the end of the course.

There are, of course, arguments for and against each of the attitudes, illustrated above. It seems important to the writer that instructors reach a working agreement, in view of the growing social importance of exact information
concerning future citizens. The basis of marking, whatever the basis may be, in general rests upon two methods: the personal estimate of the instructor, and written examinations.

Much experimental data has been published which demonstrates the inaccuracies of marks in general. Starch and Elliot (15) had a final examination paper in high school English graded by one hundred and forty-two English teachers in as many high schools. The scores ranged all the way from sixty-four to ninety-eight per cent.

The written examination also exhibits weaknesses of personal estimate. The answers to questions in many cases are evaluated subjectively. The influence of features, such as physical form of the paper, punctuation, and general grammatical form, rhetorical skill, etc., are generally underestimated.

It would appear that grades are whatever the individual instructor makes them. In some cases the extreme of individualism is offset to some degree by various rules, as when authority requires distributions approximately normal. Realizing that marks are not perfect as a criterion of academic success the writer accepts the marks as the only criterion possible to use at present.

Material used in this study. The gross scores of the
Psychological Examination, the Massachusetts State College Scholastic Aptitude Test, Forms Alpha and Beta were recorded. The composite score of these three tests was also computed. The individual scores of the Beta test were tabulated. The first and second term marks were obtained by special permission from the Office of the Dean.

The summary of the essential data used in this investigation is as follows:

a. 295 subjects.

b. The Massachusetts State College Scholastic Aptitude Test, Forms Alpha and Beta, and the Psychological Examination.

c. The gross scores obtained on each of these tests and the composite score.

d. The individual scores of the Beta test.

e. The term marks and the average marks obtained during the first and second terms of the 1932-1933 academic year.
CHAPTER III
PRELIMINARY ANALYSIS OF DATA

When marks are used collectively it is necessary to determine whether or not they are representative of the group. The principle underlying grouping is that "all measures within a class are symmetrically distributed about or concentrated at the mid-point of that class (16). It has been found by empirical studies that many and indeed probably most, human traits approach a normal distribution when tabulated and therefore are presented graphically as normal frequency curves. The normal frequency distribution is the most common occurrence in educational and biological data and its representation is known as the frequency curve, the curve of error, the normal probability curve, and the Gaussian curve (17). Otis (18) says that "if the judgment of the teacher were expressed in true numerical terms, the measures of any fairly large group would be distributed approximately according to the law of normal distribution." We may assume then in view of these statements that the marks acquired by a fairly large group of students will approximate this normal distribution. If this does not occur, it may be concluded that the course is "too easy" or "too difficult" (19).

The frequency distribution represented by a histogram is used in this study because of its value in comparing and contrasting clearly and effectively two fairly large measures.
of paired facts (20). The histogram is selected so that a comparison may be made with the frequency distributions presented by Holway (21) and because it may be more readily understood than other forms of graphs.

No restriction is placed on the size of intervals to be used except that they be equal (22, 23). In general a number of groups less than ten leads to inaccuracy and a number over thirty makes somewhat unwieldy table (24). These limits are adhered to here. Some measures of central tendency are presented here (25) but in general the comparison in this section will be limited to a description evaluation of the frequency distributions. The preliminary analysis is concerned primarily with qualitative comparisons. Mathematical comparisons will be made by the method of correlation in later chapters.

In Figure 1 is found a histogram representing the frequency distribution of the 295 average marks of the freshman class for the first term. The shape of this graph approximates fairly well that of the normal frequency curve. The marks cluster about the middle and slope symmetrically from the highest point, the center. The "average", or mean, of the marks of the first term is 71.5. The mode, or mark of greatest frequency is 72.7 and the median, the middle term is 71.9. The standard deviation, the measure of the degree to which the average marks deviate from the arithmetic mean,
TABLE 1
Calculation of the Median of a Frequency Distribution
The Measures are the Average Marks for the First Term

<table>
<thead>
<tr>
<th>Scale Intervals</th>
<th>f</th>
</tr>
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<tbody>
<tr>
<td>86</td>
<td>8</td>
</tr>
<tr>
<td>82</td>
<td>22</td>
</tr>
<tr>
<td>78</td>
<td>41</td>
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<tr>
<td>74</td>
<td>48</td>
</tr>
<tr>
<td>70</td>
<td>56</td>
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<tr>
<td>66</td>
<td>35</td>
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<td>62</td>
<td>43</td>
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<td>58</td>
<td>26</td>
</tr>
<tr>
<td>54</td>
<td>14</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>295</td>
</tr>
</tbody>
</table>

\[
\text{Md.} = L + \frac{\frac{1}{2}N-S}{f} \\
= 70 + \frac{\frac{1}{2}295 - 120}{56} (4)
\]

\[
= 70 + \frac{27.5}{56} (4)
\]

\[
\text{Md.} = 71.96
\]

Method taken from Odell, C.W., op.cit., p.126
TABLE 2

Computations of the Mean of a Frequency Distribution
The Measures are the Average Marks for the
First Term

<table>
<thead>
<tr>
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<th>Intervals</th>
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<th>d</th>
<th>fd</th>
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<td>+4</td>
<td>32</td>
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</tr>
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<td>82</td>
<td>22</td>
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<td>78</td>
<td>41</td>
<td>+2</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>74</td>
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<td>+1</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>56</td>
<td>0</td>
<td>+228</td>
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<tr>
<td>66</td>
<td>35</td>
<td>-1</td>
<td>-35</td>
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<td>54</td>
<td>14</td>
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<td>-56</td>
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</tr>
<tr>
<td>50</td>
<td>2</td>
<td>-5</td>
<td>-10</td>
<td></td>
</tr>
</tbody>
</table>

N = 295

c = -0.125

Ass. M = 72.00
M = 71.50

Method taken from Odell, C.W., op. cit., p. 125
### TABLE 3

Calculation of the Mode of a Frequency Distribution

The Measures are the Average Marks for the First Term

<table>
<thead>
<tr>
<th>Scale Intervals</th>
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N 295

Method taken from Odell, C.W., op.cit., pp. 89-93

\[
Z(\text{mode}) = 3\text{Md} - 2\text{M} = 3(71.91) - 2(71.5) \\
Z = 72.7
\]
TABLE 4

Calculation of the Standard Deviation of a Frequency Distribution
The Measures are the Average Marks for the First Term

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</tbody>
</table>

| 66 | 35 | -1 | -35 | 38 |
| 62 | 43 | -2 | -86 | 172 |
| 58 | 26 | -3 | -78 | 234 |
| 54 | 14 | -4 | -56 | 224 |
| 50 | 2  | -5 | -10 | 50 |

\[ \begin{align*}
\text{fd}^2 & = 1228 \\
\text{S} & = 295 \\
c^2 & = -0.125 \\
\text{C} & = 0.0156 \\
\sigma & = 4.2243 \\
\text{Method} & = 2.055 \text{int.units} \\
\end{align*} \]

Method taken from Odell, C. W., op. cit., p. 132.
is 8.22 (Cf. Table 4, p. 19), in terms of the items, average marks.

Figure 2 shows the frequency distribution of the 294 first term marks in Orientation. This distribution is fairly symmetrical being skewed only slightly to the left.

The law of normal distribution is violated more noticeably in the case of the Mathematics term marks (figure 3). The curve is definitely skewed to the right. The five division classification of Starch (26) is violated. This classification is 7% E, 24% D, 38% C, 24% B, and 7% A. There are 51 marks below 60% or 18% in the E class with only 6% in the A class to offset this. The standard deviation is 8.8 indicating that over 65% of the marks fall between 69.0 ± 8.8 (69.0 = mean). If this group is a representative one, as shown by the distribution of the average marks, the large number (51) below 60 can only lead to the belief that the work is evidently quite difficult.

The curve presented by the English term marks little resembles a normal curve (Figure 4). Approximately 50% fall below the 70 mark, while 59 are conditions or failures. We may assume that the work is rather difficult.

The frequency distribution of the Chemistry term marks (Figure 5) is fairly symmetrical. The number of failures or conditions, 39, is somewhat large, but this is partially offset by the 51 marks above 85. The actual mean 71.3 departs
FIGURE 1

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term Average Marks

(295 cases)

Frequency

First term average marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 2

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term Orientation Marks

(294 cases)

First term Orientation marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions

Frequency
FIGURE 3

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term Mathematics Marks

(272 cases)

First term Mathematics marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 4

Histogram showing the Actual and Theoretical Frequency Distributions of the First Term English Marks

(294 cases)

First term English marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 5

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term Chemistry Marks

(295 cases)

First term Chemistry marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
only 4 points from the theoretical mean 75.3.

The distributions of the French and German term marks are presented separately and in composite (Figures 6, 7, and 8). The French term marks are fairly symmetrical although the mean 71 is somewhat below the theoretical mean of 75. The 11 failures or conditions are somewhat high but perhaps are offset by the 10 marks above 85. There are 59% of the marks above 70 but only 1 mark in the upper fifth. It is doubtful if Dr. Starch would approve the distribution. An inspection of the German term mark distribution reveals a very flat curve with a distinct grouping at the 85-90 column. A majority of marks range from 70 to 95, while approximately 41% fall below 70. About 9% (12) of the marks fall in the upper fifth partially balancing the 17% (21) below 60. When the composites of the French and German term marks are presented the curve presents a more normal distribution. Over 13% of the marks are under 60 while only 5% are above 90. The language courses are apparently quite difficult.

The frequency distribution for the second term average marks (Figure 9) is skewed slightly to the right. The majority of the marks lie between 65 and 80, with but 8 average marks below 60.

The Chemistry second term marks do not present a very normal curve. The central columns are too low, -- while
FIGURE 6

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term French Marks

(102 cases)

Frequency

First term French marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 7

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term German Marks

(128 cases)
FIGURE 8

Histogram Showing the Actual and Theoretical Frequency Distributions of the First Term German and French Marks

(250 cases)
FIGURE 9

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term Average Marks

(261 cases)
those on either side are too high; e.g., columns 1, 2 and 3, and 7, 8 and 9 (Figure 10). There are 24 marks below 60 with but 13 above 90. Freshman Chemistry is apparently quite difficult.

In Figure 11, the frequency distribution of the second term Orientation marks shows a skew to the left. Only 4 term marks fall below 60, while 13 fall above 90. Over 83% of the 261 marks (219) are above 70.

Of the 258 English second term marks (Figure 12), 24 are conditions or failures. In the upper fifth, i.e., above 90, there are only 3 term marks. The difficulty of English seems apparent.

The second term marks for Mathematics vary considerably from the theoretical curve of symmetry (Figure 13). The term marks tend "to spread" more than is necessary. The central columns are too low, while columns 1, 2, and 3, and 8, 9 and 10, are too high. Of the 234 term marks 48% are below 70, with 16% in the lower fifth, while 8% are in the upper fifth.

The French and German mark frequency distributions for the second term are shown in Figures 14 and 15 respectively. The 83 French marks are fairly symmetrical. Any better distribution could not be expected with so few cases. There are 4 marks in the lower tenth, i.e., below 55, and none in the upper tenth, i.e., above 95. The German marks present
FIGURE 10

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term Chemistry Marks

(244 cases)

Frequency

Second term Chemistry marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 11

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term Orientation Marks

(261 cases)

Frequency

Second term Orientation marks

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 12

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term English Marks

(258 cases)

Frequency

Second term English marks

Represents actual frequency distributions

Represents theoretical frequency distributions
FIGURE 13

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term Mathematics Marks

(254 cases)
FIGURE 14

Histogram showing the Actual and Theoretical Frequency Distributions of the Second Term French Marks

(83 cases)
FIGURE 15

Histogram showing the Actual and Theoretical Frequency Distributions of the Second Term German Marks

(108 cases)
an irregular distribution but again the number of cases are too few (108).

The French and German composite marks for the second term are presented in Figure 16. Of the 191 marks 15 are below 60 while 7 are above 90. The largest number of marks (35) are between 85 and 90.

The gross scores of the Psychological Examination are presented in Figure 17 showing the actual and the theoretical normal frequency distributions. The curve is skewed to the right. Holway (27) states that "the Psychological Examination should be so revised as to foster a more normal distribution, or to better fit the average mark distribution." This is a logical assumption as the same number of cases is used to determine both the actual and the theoretical distribution of these gross scores.

Figure 18 shows the frequency distribution of the Massachusetts State College Scholastic Aptitude Test, Form Alpha gross scores. A closer approximation to the theoretical distribution would be desirable. The scores are more in evidence on the right hand side of the curve showing that the test is a bit easy. However, the frequency distribution of the gross scores of this test approximates the theoretical more closely than does the Beta form of the same test or the Psychological Examination.
FIGURE 16

Histogram Showing the Actual and Theoretical Frequency Distributions of the Second Term French and German Marks

(101 cases)
FIGURE 17

Histogram Showing the Actual and Theoretical Frequency Distributions of the Psychological Examination Gross Scores

(300 cases)

Psychological examination gross scores

- Represents actual frequency distributions
- Represents theoretical frequency distributions
FIGURE 18

Histogram showing the actual and theoretical frequency distributions of the alpha gross scores

(295 cases)

Frequency

Alpha gross scores

Represents actual frequency distributions

Represents theoretical frequency distribution
The gross scores of the Massachusetts State College Scholastic Aptitude Test Form Beta (Figure 19) are skewed to the right. It would seem that this test is quite difficult for entering freshmen. This difficulty could be partially overcome by making certain sections, which are consistently low in marks, easier; (Cf. Sec. V. Frequency Distributions Figure 25).

Figure 20 shows the actual and theoretical normal frequency distributions of the Composite scores. The curve is fairly symmetrical, tending, however, to be somewhat skewed to the right. This skewness could be corrected by increasing the number of items or problems in each of three tests or by eliminating or making easier the difficult parts of the tests.

A study of the frequency distribution curve for the individual scores obtained on Section I of the Beta test, (Figure 21) reveals that it deviates from the normal. The curve is skewed to the right, and is thus classified as difficult.

The curve of the individual scores of Section II (Figure 22) is spread out too much. The center columns could be raised to the desired height by altering this section to force the measures to cluster more about the center.

Figure 23 shows the distribution of the individual
FIGURE 19

Histogram showing the actual and theoretical frequency distributions of the Beta Gross Scores

(205 cases)
Figure 20

Histogram Showing the Actual and Theoretical Frequency Distributions of the Composite Scores

(298 cases)
FIGURE 21

Histogram showing the actual frequency distribution of the Section I individual scores.

"Massachusetts State College Scholastic Aptitude Test, Form Beta"

(295 cases)

Section I individual scores (Beta Test)

--- Represents actual frequency distributions
FIGURE 22

Histogram Showing the Actual Frequency Distribution of the Section II Individual Scores "Massachusetts State College Scholastic Aptitude Test, Form Beta"

(295 cases)

Section II individual scores (Beta Test)

- Represents actual frequency distributions
FIGURE 23

Histogram Showing the Actual Frequency Distribution of the Section III Individual Scores
"Massachusetts State College Scholastic Aptitude Test, Form Beta"

(295 cases)

Section III individual scores (Beta Test)

--- Represents actual frequency distributions
scores of Section III. This test is possibly "too difficult". Possibly the elimination of some of the material or a longer time limit would aid in bringing about a more normal distribution.

The histogram representing the frequency distribution of the Section IV individual scores (Figure 24) indicates to a marked degree that the section is too difficult. The maximum is reached in the second column and the curve slopes downward to column 6. The law of normal distribution is definitely violated.

Figure 25 showing the individual scores of Section V is even more violently skewed to the right. Ninety-three per cent of the cases fall in the lower half of the curve. A change in the construction of this section is needed to approximate more nearly the normal curve.

The shape of Section VI individual scores distribution (Figure 26) indicates that the items could profitably be increased in number and (slightly) in difficulty.

A general consideration of the Beta test gross scores indicates that for the purpose of mathematical comparison, several changes should be made. First, each single test is too difficult with the possible exception of Section II and Section VI. Section IV and Section V are exceptionally difficult, no mark being received above 15 with a large per-
FIGURE 24

Histogram Showing the Actual Frequency Distribution of the Section IV Individual Scores
"Massachusetts State College Scholastic Aptitude Test, Form Beta"

Frequency

(295 cases)

Section IV individual scores (Beta Test)

Represents actual frequency distributions
FIGURE 25

Histogram Showing the Actual Frequency Distribution of the Section V Individual Scores
"Massachusetts State College Scholastic Aptitude Test, Form Beta"

Frequency

(295 cases)
FIGURE 26

Histogram Showing the Actual Frequency Distribution of the Section VI Individual Scores of "Massachusetts State College Scholastic Aptitude Test, Form Beta"

(395 cases)

Section VI individual scores (Beta Test)

--- Represents actual frequency distributions
percentage of students receiving no credit, (11% Section V, 1% in Section IV).

Summary and interpretation. A qualitative account of the frequency distributions of instructors' marks for the first and second terms shows (a) that the first and second term average marks tend to approximate the normal-frequency curve, (b) that with few exceptions the distributions of the term marks are "irregular" or abnormally skewed. There are also discrepancies revealed in the composite, gross and individual score frequency distributions. These discrepancies may be partially removed as the tests may be more or less readily revised. Any attempt to change the mark distribution, however, is another matter and is subject to all of the difficulties previously described. (Cf. p.10, Examination of criteria of academic success.) The results here presented indicate rather definitely that it is with the instructor and his marks which the test investigators now have to deal if the predictive validity of tests are to be improved.
CHAPTER IV

SECONDARY ANALYSIS OF DATA

Methodology. The method used to determine the comparative efficiency of the Psychological Examination, the Form Alpha and the Form Beta of the Massachusetts State College Scholastic Aptitude Test in predicting the academic success of college freshman (Class of 1936), during the first term of the 1932-1933 academic year, is the product-moment method of correlation devised by Karl Pearson (28). The exact form used here is taken from Monroe (29). Correlation, or the correlation index, may be called, in a general way, a study of paired facts; that is to say, it is not possible to compute a correlation unless there are available for each individual two or more parts or measures (30). Moreover, although correlations are often computed for the purpose of studying causation, this is not necessarily implied. Whether one of the two variables affects the other, or some other factor (variable) affects both, the correlation index give no suggestion. The coefficient of correlation ranges from a perfect positive correlation of +1, through zero, to a perfect negative correlation of -1. Experts do not agree on the exact significance of the correlation coefficient. H. D. Rugg (31) states that for use in education a correlation less than .15 or .20 is "negligible"; one ranging from .15
or .20 to .35 or .40 is "present but low"; from .35 or .40
to .50 or .60, it is "marked" or "markedly present"; and
from .60 or .70 up, the correlation is "high".

Another standard is presented by Trow (32). A very
low correlation lies between .05 to .20; one from .20 to
.40 is low; from .40 to .60 is substantial; from .60 to .80
is high; and from .80 to .95 the correlation is very "high".

Harper (33) quotes King as suggesting the following rules:

1. 'If \( r \) is less than the probable error there
   is no evidence whatever of correlation.'

2. 'If \( r \) is more than six times the size of the
   probable error the existence of correlation is
   a practical certainty.'

3. When the probable error is relatively small,
   'if \( r \) is less than .50 the correlation cannot be
   considered at all marked.'

4. If the probable error is relatively small, a
   coefficient 'above .50 indicates decided corre-
   lation.'

It is almost impossible, in view of these different
standards, to set up any measuring stick that will apply
to all cases. A correlation may be "low" with reference to
the perfect correlation (\( r = .1 \)) and yet may be "high" when
evaluated with other correlations between the same two variables. Generally speaking, the test with the highest correlation is the best prognosticator of academic success. More specifically, however, this statement is not necessarily true. The correlation coefficient may be "low" and yet may pick success or failure very efficiently. The percent of forecasting efficiency is determined in this study by Kelley's formula for the coefficient of alienation, \( K_a = (1 - r^2)^{1/2} \). The alienation coefficient, \( K_a \), shows the lack of relationship in percent, and consequently the inaccuracy of any prognosis based on the relationship. Therefore, the complement of the value of \( K_a \), \( (K_a = 1 - K_a) \) expressed in percent, gives the prognostic efficiency of the correlation coefficient (34).

It is necessary also to test the reliability of a correlation coefficient. The index of dependability is the probable error (P.E.r). The ratio which should exist is in dispute. Different authorities place the ratio from 2 to 6, that is, the coefficient of correlation should be that many times greater than the probable error. In this study the coefficient is considered valid when it is at least 6 times the probable error.

A survey of the work done in prediction shows that the index .40 is above average for the prediction of success in
the first year of college work.

We have then, set up various guide posts or standards upon which future work is to be based. In general, the test showing the greatest correlation is the best prognosticator of academic success; the percent of forecasting efficiency is indirectly determined by Kelley's formula; the normal or average of success thus far attained is an index of .40 (35); the correlation coefficient must be at least 6 times the probable error.

Composite scores and average marks. The coefficient of correlation between the composite scores and average marks for the first term is .523; the probable error ± .042. The chances are that the true correlation lies between .48 and .56 (36). A positive relationship exists between the two kinds of responses x being over 6 times the probable error and 12 points higher than the "average" index of these responses.

Results are not as satisfactory when the index is interpreted in terms of forecasting efficiency. The value of the coefficient of alienation is slightly better than 15, which means that future academic success can be predicted with only 15% accuracy. This is an increase of over 85% in prognostic efficiency over the "average" indices.

The next obtained coefficient, .519 ± .030, is that
Section IV
Form Beta

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\[
x = \frac{2347}{2} = 1.57
\]
\[
x = \frac{2347}{2} = 1.64
\]
\[
y = 2.715
\]
\[
y = 2.87
\]
\[
x = \frac{1}{0.337}
\]
\[
x = \frac{1}{0.337}
\]

Method of Computing the Coefficient of Correlation
existing between the Composite scores and the second term average marks. That a positive relationship is present is indicated by the fact that this index is well over 12 times the probable error. In regard to forecasting efficiency this test is nearly 15% accurate.

Gross scores and average marks (Cf. Table 5). The correlation between the gross scores of the Alpha test and the first term average marks is $0.467 \pm 0.030$. The coefficient may be considered reliable since the index is 15 times the probable error. It can be readily seen that this index is above the average. The chances are even that, if this test were given again next year, other factors being equal, a correlation would be between $0.464$ and $0.470$ and the chances are 25 to 1 that the correlation would be at least $0.458$. The results also show that the test is 11% accurate in forecasting efficiency.

The index $0.394 \pm 0.035$ shows the extent to which a change in the gross scores of the Alpha test tends to be accompanied by a change in the second term average marks. The index is over 6 times the probable error — indicating dependability. This figure is 9 points below the first term average marks correlation with the Alpha test. The forecasting accuracy of the section is 8%.

The gross scores of the Psychological Examination give
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<th>Number of Cases</th>
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<td>First term Average marks</td>
<td>.481 ± .029</td>
<td>.467 ± .030</td>
<td>.305 ± .035</td>
<td>.523 ± .042</td>
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<td>Second term Average marks</td>
<td>.482 ± .031</td>
<td>.394 ± .0350</td>
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<td>.430</td>
<td>.339</td>
<td>.521</td>
</tr>
</tbody>
</table>
a correlation coefficient, when compared with average marks, of \(.4815 \pm .0296\). As a prognostic indicator it is 13% efficient. This is more valid than the "learning test", Alpha, by 2 points and 3 points higher than the "learning test" Beta.

The correlation existing between the Psychological Examination gross scores and the second term average marks \(.432 \pm .031\) is very nearly the same as that obtained with the first term marks.

The gross scores of the Beta test, the measures presumably based on ability to learn nonsense material, when compared with average marks give a correlation coefficient of \(.305 \pm .035\). The index is well over 6 times the probable error and a definite relationship may be assumed. The coefficient of alienation indicates that the test is of little prognostic value being less the 5% efficient. The results of this first comparison show that the test essentially measuring past experience is more valid than either test based upon "ability to learn." The test based upon "ability to learn" sense material is more valid than the one based upon "ability to learn nonsense" material.

The correlation between the Beta test gross scores and the second term average marks is \(.374 \pm .035\) showing an increase in forecasting efficient from 5% to 8%. Students with low average marks evidently ranked normally or above
normal in the Beta test. This hypothesis needs more evidence to substantiate it. Chapter IV will attempt to do this.

**Gross scores and term marks.** The correlation coefficients secured between the gross scores and the first term marks are shown in Table 6. The index between the Psychological Examination and the Orientation first term marks is \( r = 0.445 \pm 0.031 \) \((N = 294)\). There is evidently a high positive relationship between the test and the term marks. The forecasting efficiency of 10% is higher than the average.

The Alpha gross scores and the Orientation first term marks \((N = 294)\) produce a higher coefficient than the Psychological Examination index \( r = 0.571 \pm 0.026 \). The prognostic value is increased from 10 to 17%. This shows an increase of 17 points above the normal and means that the chances are 1 to 1 that the true correlation is at least 0.545 at best 0.597.

The Beta test when compared with Orientation shows the lowest correlation of the three, \( r = 0.383 \pm 0.033 \) \((N=294)\). The test is but 8% efficient making it impracticable as a prognosticator.

The coefficient obtained by comparing the Psychological Examination gross scores with the Mathematics first term marks is \( r = 0.308 \pm 0.036 \). We may assume a positive relationship
### TABLE 6

Correlations Among Gross Scores and First Term Marks

<table>
<thead>
<tr>
<th>Term Marks</th>
<th>Psychological Gross Scores</th>
<th>Alpha Gross Scores</th>
<th>Beta Gross Scores</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>.443 ± .031</td>
<td>.571 ± .026</td>
<td>.383 ± .033</td>
<td>294</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.308 ± .036</td>
<td>.362 ± .035</td>
<td>.285 ± .03</td>
<td>272</td>
</tr>
<tr>
<td>Chemistry</td>
<td>.408 ± .032</td>
<td>.455 ± .031</td>
<td>.382 ± .033</td>
<td>295</td>
</tr>
<tr>
<td>English</td>
<td>.430 ± .032</td>
<td>.340 ± .034</td>
<td>.353 ± .034</td>
<td>294</td>
</tr>
<tr>
<td>French</td>
<td>.474 ± .051</td>
<td>.314 ± .06</td>
<td>.343 ± .058</td>
<td>102</td>
</tr>
<tr>
<td>German</td>
<td>.172 ± .057</td>
<td>.172 ± .057</td>
<td>.083 ± .059</td>
<td>128</td>
</tr>
<tr>
<td>Average Index</td>
<td>.36</td>
<td>.36</td>
<td>.30</td>
<td></td>
</tr>
</tbody>
</table>
although the index is only three-fourths as large as the normal and is less than 5% accurate as regards forecasting efficiency.

There is an increase of 6 points in the coefficient of correlation between the Alpha gross scores and the Mathematics first term marks: \( r = .362 \pm .035 \). The test is but 6% efficient and is therefore almost useless for prediction.

An examination of the index existing between the gross scores of the Beta test and the first term Mathematics marks reveals that the Beta test is of less efficiency than the other two. The correlation is \( .285 \pm .03 \) and is but 4% efficient.

The correlation existing between the Psychological Examination gross scores and the first term Chemistry marks is \( .408 \pm .032 \). This index is normal with a prognostic efficiency of 8%.

The correlation \( .455 \pm .031 \) existing between the gross scores of the Alpha test and the first term marks in Chemistry shows a gain of 5 points above the normal with an efficiency of 11%.

The correlation coefficient between the Beta gross scores and Chemistry first term marks \( .382 \pm .033 \) is somewhat less than that existing between the other two tests. The accompanying efficiency index is nearly 8%. 
The index existing between the Psychological Examination gross scores and the English first term marks is \( \text{.43} \pm \text{.032} \) (\( N = 294 \)). Its predictive value is nearly 10\% efficient.

Between the Alpha test gross scores and the first term English marks the relationship is below the average but is positive and reliable, \( r = \text{.34} \pm \text{.034} \) (\( N = 294 \)). This shows a loss of 9 points over the Psychological Examination and is 1 point below the Beta test index. The predictive value of this test is of little use for English marks, being but 6\% efficient.

A coefficient of correlation of \( \text{.353} \pm \text{.034} \) exists between the gross scores of the Beta test and the English first term marks. This index is only seven-eighths as large as the normal and has a corresponding coefficient of efficiency of 7\%.

An examination of the indices existing among the gross scores of the three mental tests and the German first term marks reveals that none is significant. In no case is the coefficient of correlation sufficiently larger than the probable error to assume any relationship. This may be partially accounted for by the fact that not enough cases (\( N = 128 \)) are available.

The index existing between the Psychological Examination gross scores and the French first term marks is \( \text{.474} \pm \)
.051 (N = 102). As this figure .474 is well over 6 times the probable error a rather definite relationship may be assumed. With respect to forecasting efficiency, it is higher (12%) than either of the other two tests.

A correlation of .314 ± .060 exists between the gross scores of the Alpha test and the first term French marks. Although this index is not 6 times the probable error it would undoubtedly be accepted as dependable. As a prognosticator this test is less than 5% accurate.

The gross scores of the Beta test, when compared with the French marks, give a correlation coefficient of .345 ± .054. In this instance, the index is over 6 times the probable error. The test has a prognostic efficiency of 7%.

The correlations among the mental test gross scores and the separate term marks indicate that the Psychological Examination and the Massachusetts State College Scholastic Aptitude Test, Form Alpha are superior to the Massachusetts State College Scholastic Aptitude Test, Form Beta. The average indices are .36, .36, and .30 respectively. The first two average indices are only 4 points below the normal and are 6 points higher than the Beta test.

Individual scores and average marks. The study of the correlations existing among the individual scores and the average marks is limited to the Massachusetts State College
Scholastic Aptitude Test, Form Beta. The reasons for this limitation are three-fold. First, the time required to carry these tests through to completion is prohibitive. Furthermore, previous studies have fairly well established the status of the Psychological Examination at this college (37). Form Alpha of the Massachusetts State College Scholastic Aptitude Test has been carefully analyzed and compared by Holway (38) using the first term marks of the 1931-32 academic year.

The various coefficients obtained by correlating the individual scores of the Beta test and the average marks of the first term are presented in Table 7. The coefficient, .303 ± .035, represents the relationship between Section I of the Beta test and the first term average marks. The index is well over 6 times the probable error, showing that the relationship is significant and dependable. The section is 10 points lower than the average with a prognostic efficiency of but 5% making its use for predictive purposes impractical.

The coefficient of correlation existing between Section II of the Beta test and the average marks is .327 ± .035. This figure is 3 points below the normal, is about 6% efficient prognostically, and is of little, if any, practical use for prediction. The correlation may be considered reliable, since it is more than 6 times the probable error.
<table>
<thead>
<tr>
<th>Section I</th>
<th>Section II</th>
<th>Section III</th>
<th>Section IV</th>
<th>Section V</th>
<th>Section VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Marks</td>
<td>0.303 ± 0.035</td>
<td>0.327 ± 0.035</td>
<td>0.200 ± 0.037</td>
<td>0.377 ± 0.033</td>
<td>0.183 ± 0.037</td>
</tr>
</tbody>
</table>
The extent to which a change in the Section III of the Beta test tends to be accompanied by a change in the first term average marks is \( .200 \pm .037 \). This index is 20 points below normal and is useless for prediction being only 3\% efficient as a prognostic indicator.

The individual scores of the Section IV of the Beta test correlate \( .377 \pm .033 \) with the average marks. This means that the relationship is dependable. This coefficient is less than 3 points below the normal and is 8\% accurate for use in prediction.

It is doubtful if any relationship exists between Section V individual scores and the average marks for the first term. The correlation coefficient, \( .183 \), is barely 6 times the probable error, \( \pm .037 \). The coefficient is 22 points below normal, indicating that the section is less than 2\% accurate, and useless for predictive purposes.

Section VI individual scores correlates \( .260 \pm .036 \) with the first term average marks. The index is well over 6 times the probable error and, hence, the relationship is reliable and probably positive. Yet it is 15 points below the normal and for prediction it is about 4\% efficient.

Summary and interpretation. The following statements seem justifiable in the light of the results presented in this chapter.
(1.) The composite of the gross scores is the most valid general measure of academic success ($r = .523 \pm .042$).

(2.) The Psychological Examination ranks slightly higher in prognostic validity, ($r = .481 \pm .029$), when correlated with first term average marks than the Massachusetts State College Scholastic Aptitude Test, Form Alpha ($r = .467 \pm .030$). The Massachusetts State College Scholastic Aptitude Test, Form Beta is the lowest ($r = .305 \pm .035$).

(3.) Although some of the coefficients of correlation obtained between the gross scores and first term marks are significant, most of them show that the tests are of very little prognostic value.

(4.) In no instance do any of the correlations secured among the individual scores of the Massachusetts State College Scholastic Aptitude Test, Form Beta and the first term average marks show an index above the normal (about .40). Accurate prediction using the individual scores of the Beta test is therefore improbable.

Thus far, there is no indication that the "learning" test based upon the use of nonsense material in its present form will "live up" to the expectations of its authors (Cf. p. The Beta Test). It is inferior to its parent test, the "Learning" test based upon sense material. Both of these tests at present seem to be somewhat less efficient.
than the Psychological Examination, based primarily on recognition and recall. When compared with the normal, both the Psychological Examination and the Massachusetts State College Scholastic Aptitude Test, Form Alpha are above that value.

The above results are by no means final or conclusive. The writer realizes "full well" the real limitations involved in this study. Only after further experimentation and more extended researches can final conclusions be drawn (39).
CHAPTER V
PERCENTILE INTERPRETATION

The conclusions reached at the close of the last chapter seem to indicate that the mental tests, used in this study, are of little practical, general, prognostic value, when compared with an absolute standard but valuable when compared with the standards already in use. It is necessary, however, to investigate further the validity of these mental tests. The method used here is the percentile comparison; the percentile being a quartile or quarter, and the computation, the coefficient of correspondence. Odell (40) defines this index as the per cent of individuals who have the same relative position within the group in one series of measures as they have in the other. The coefficient of correspondence is determined by directly comparing the number of items in the same quartile with the total number of items in each quartile. In this study the marks and scores are ranked in order, from the highest to the lowest. Each series is divided into quartiles, or quarters. The highest is the fourth, or upper quartile, while the lowest is the first, or lower quartile. The number of corresponding measures which fall in the fourth quartile, for example, is computed and this number divided by the total number of cases in the quartile. The quotient is the coefficient of correspondence.
A quartile comparison showing degrees of correspondence between first term average marks and mental test composite and gross scores is presented in Table 8. The number of cases which are in the same quartile is given in Column 2. Columns 3, 4, and 5 show the cases differing by one, two and three quartiles. The next column is the Total Misplacement. This figure is the sum of the cases that do not fall in corresponding quartiles of the mental test gross scores and the first term average marks. The point misplacement is found by adding the moments of quartile displacement. The number of cases differing by one quartile is multiplied by one, the number differing by two is multiplied by two, etc. The sum of these products equals the total point misplacement. The test which has the lowest point misplacement is obviously the most valid.

First quartile comparison between average marks and mental test scores. The amount of correspondence existing between the first term average marks and the mental test composite and gross scores is presented in Table 8. The Beta test has the lowest coefficient of correspondence, .364; the Alpha test is second, .406, while the Psychological Examination is first, .420. The Beta test has the highest point misplacement and the Psychological Examination has the lowest. Of the three tests, the gross scores of the
<table>
<thead>
<tr>
<th>Mental Tests</th>
<th>Same Quartile</th>
<th>Differ by One Quartile</th>
<th>Differ by Two Quartiles</th>
<th>Differ by Three Quartiles</th>
<th>Total Displacement</th>
<th>Point Displacement</th>
<th>Coeff. of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. S. C. Form Alpha</td>
<td>120</td>
<td>119</td>
<td>49</td>
<td>7</td>
<td>175</td>
<td>238</td>
<td>.406</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. S. C. Form Beta</td>
<td>114</td>
<td>120</td>
<td>50</td>
<td>11</td>
<td>181</td>
<td>253</td>
<td>.335</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological</td>
<td>124</td>
<td>121</td>
<td>38</td>
<td>12</td>
<td>171</td>
<td>233</td>
<td>.420</td>
</tr>
<tr>
<td>Examination (gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite</td>
<td>131</td>
<td>115</td>
<td>42</td>
<td>7</td>
<td>164</td>
<td>220</td>
<td>.444</td>
</tr>
</tbody>
</table>

(295 cases)
Psychological Examination deviate less from the criterion array than the other two tests. The point misplacement is only 5 points less than that of the Alpha test. The Psychological Examination has the lowest total misplacement, and although but 4 points below the Alpha it is 10 points lower than the Beta.

The Alpha test predicts the same relative position within a quartile with 81% accuracy. The Beta test predicts the same relative position within a quartile with 79% accuracy; the Psychological Examination with 83% accuracy. The Composite is also 83% accurate. Only 16% of the students differ by two or three quartiles in regard to the Psychological Examination. These results would seem to indicate that the Psychological Examination is the best of the three tests, since it forecasts 83% efficiently and has the highest coefficient of correspondence. This test is superior, in this regard, to both of the "learning" tests although inferior to the Composite scores. The Composite has a higher coefficient of correspondence with the lowest point misplacement.

Second quartile comparison. The quartile comparisons between the first term average marks and (a) the Alpha gross scores, (b) the Beta gross scores, (c) the Psychological Examination gross scores, and (d) the Composite scores are presented in Tables 9 to 12. The average marks and the gross
and composite scores are compared directly, quartile by quartile.

Table 9 presents the quartile comparisons between the first term average marks and the Alpha gross scores. The number of students who were placed in the upper quartiles in both averages marks and the Alpha test gross scores is 41. Of the total number of students in the upper quartile of the average marks 52% were predicted by the Alpha test. This study is more concerned, however, with the first quartile, as the prediction of failure is closely connected with academic success. The coefficients of correspondence show that the Alpha test predicts first quartile average marks 44% efficiently and fourth quartile average marks 52% efficiently. This test is more accurate in predicting success than failure.

The results obtained by comparing the first term average marks with the Beta test gross scores is presented in Table 10. Forty-five cases were accurately placed in the fourth quartile (41). That this test is 57% efficient is shown by the coefficient of correspondence. The Beta test is more accurate than the Alpha test in predicting students in the upper quartile. The first quartile placement (42) is 36% accurate which is slightly lower than the Alpha test.

Table 11 contains the results obtained by comparing the
### TABLE 9

Quartile Comparison Between the First Term Average Marks and the Massachusetts State College Scholastic Aptitude Test, Form Alpha Gross Scores

<table>
<thead>
<tr>
<th>Average Marks</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Total Misplacement</th>
<th>Point Misplacement</th>
<th>Coef. of Corresp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth</td>
<td>41</td>
<td>23</td>
<td>13</td>
<td>1</td>
<td>37</td>
<td>62</td>
<td>.525</td>
</tr>
<tr>
<td>Third</td>
<td>22</td>
<td>24</td>
<td>16</td>
<td>15</td>
<td>55</td>
<td>68</td>
<td>.311</td>
</tr>
<tr>
<td>Second</td>
<td>10</td>
<td>18</td>
<td>26</td>
<td>21</td>
<td>49</td>
<td>59</td>
<td>.346</td>
</tr>
<tr>
<td>First</td>
<td>6</td>
<td>11</td>
<td>19</td>
<td>29</td>
<td>36</td>
<td>69</td>
<td>.446</td>
</tr>
</tbody>
</table>

(225 cases)
<table>
<thead>
<tr>
<th>Average Marks</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Total Misplacement</th>
<th>Point Misplacement</th>
<th>Coef. of Corresp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth</td>
<td>45</td>
<td>19</td>
<td>8</td>
<td>6</td>
<td>33</td>
<td>53</td>
<td>.576</td>
</tr>
<tr>
<td>Third</td>
<td>14</td>
<td>25</td>
<td>23</td>
<td>15</td>
<td>52</td>
<td>77</td>
<td>.324</td>
</tr>
<tr>
<td>Second</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>55</td>
<td>70</td>
<td>.266</td>
</tr>
<tr>
<td>First</td>
<td>5</td>
<td>12</td>
<td>24</td>
<td>21</td>
<td>41</td>
<td>63</td>
<td>.369</td>
</tr>
</tbody>
</table>

(295 cases)
TABLE II
Quartile Comparison Between the First Term Average Marks and the Psychological Examination Gross Scores

<table>
<thead>
<tr>
<th>Psychological Examination</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Total Misplacement</th>
<th>Point Misplacement</th>
<th>Coef.of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth</td>
<td>42</td>
<td>19</td>
<td>8</td>
<td>3</td>
<td>30</td>
<td>44</td>
<td>.550</td>
</tr>
<tr>
<td>Third</td>
<td>13</td>
<td>22</td>
<td>21</td>
<td>14</td>
<td>48</td>
<td>62</td>
<td>.376</td>
</tr>
<tr>
<td>Second</td>
<td>8</td>
<td>22</td>
<td>22</td>
<td>23</td>
<td>55</td>
<td>61</td>
<td>.293</td>
</tr>
<tr>
<td>First</td>
<td>9</td>
<td>8</td>
<td>23</td>
<td>25</td>
<td>40</td>
<td>36</td>
<td>.384</td>
</tr>
</tbody>
</table>

(295 cases)
first term average marks and the Psychological Examination gross scores. Since 49 upper quartile students were accurately placed, the coefficient of correspondence is .550. This test is 38% accurate in predicting "poor" students. The Beta test apparently is the most efficient in predicting "good" students with the Alpha test second, and the Psychological Examination third. It should be noted, however, that the Psychological Examination has the lowest point misplacement being 9 points below the Beta test and 8 points below the Alpha test. The Alpha test seems to be most accurate in predicting "poor" students. The Alpha test is 44% efficient as compared with the 53% efficiency of the Psychological Examination which in the opinion of the writer more than balances the 3 point less misplacement of the Psychological Examination.

A quartile comparison between the first term average marks and the Composite scores is presented in Table 12. In the upper quartile 50 students were accurately placed indicating that the Composite is 64% efficient in regard to the selection of "good" students. The Composite is less accurate than the Alpha test but more accurate than the other two in predicting lower quartile students, being 40% efficient. Its point misplacement is 9 points below the Alpha. It seems likely that the Composite is most valid in predict-
## TABLE 12

Quartile Comparison Between the First Term Average Marks and the Composite Scores

<table>
<thead>
<tr>
<th>Average Marks</th>
<th>Composite Scores</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Total Misplacement</th>
<th>Point Misplacement</th>
<th>Coefficient of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth</td>
<td></td>
<td>50</td>
<td>18</td>
<td>7</td>
<td>3</td>
<td>28</td>
<td>31</td>
<td>.641</td>
</tr>
<tr>
<td>Third</td>
<td></td>
<td>15</td>
<td>29</td>
<td>20</td>
<td>13</td>
<td>48</td>
<td>61</td>
<td>.373</td>
</tr>
<tr>
<td>Second</td>
<td></td>
<td>9</td>
<td>17</td>
<td>26</td>
<td>23</td>
<td>49</td>
<td>68</td>
<td>.346</td>
</tr>
<tr>
<td>First</td>
<td></td>
<td>4</td>
<td>13</td>
<td>22</td>
<td>26</td>
<td>39</td>
<td>60</td>
<td>.400</td>
</tr>
</tbody>
</table>

(295 cases)
ing the success or failure of freshmen.

**First term failures.** Twenty-three students were eliminated from college at the close of the first term, of the 1932-1933 academic year, because of failure to do satisfactory work. Table 13 presents the extent that failure was predicted by the mental test composite and gross scores. The lowest quartile of the Alpha test placed 11 of the 23 failures below the 60 mark. Six are found in the next quartile; i.e., displaced by one quartile. Six students were failed out of college who were in the two highest quartiles of the Alpha test.

The Beta test placed 10, or 43% in the lowest quartile. It is significant that no student who failed was placed in the upper quartile of the Beta test gross scores, and that 79% of the cases are in the first and second quartiles.

The Psychological Examination placed 11 of the 23, or 47% in the lowest quartile. This figure is the same as the Alpha index. Two more cases are placed in the second quartile and two less in the third than are so placed by the Alpha test. It seems, therefore, that the Psychological Examination is the most efficient in placing first term failures.

Table 13 also shows the accuracy of the Composite in predicting first term failures. This places 12, or 56% of the cases in the first quartile. Nineteen of the 23 cases are in the first two quartiles with but 1 case in the upper quartile.
<table>
<thead>
<tr>
<th>Mental Test</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Coefficient of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.C. Form Alpha</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>11</td>
<td>.47</td>
</tr>
<tr>
<td>M.S.C. Form Beta</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>.43</td>
</tr>
<tr>
<td>Psychological Examination</td>
<td>3</td>
<td>1</td>
<td>8</td>
<td>11</td>
<td>.47</td>
</tr>
<tr>
<td>Composite</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>13</td>
<td>.56</td>
</tr>
</tbody>
</table>

(23 cases)
This means that the **Composite** scores are more efficient than any of the mental tests in predicting failures.

**Quartile comparison between the average of the ten highest students and the mental test composite and gross scores.** The quartile comparison between the averages of the ten highest students and the Alpha test is presented in Table 14. Four of the ten students were placed in the upper quartile of the Alpha test. The coefficient of correspondence is .40. The remaining 6 students is placed in the second and third quartiles while none are placed in the lower quartile. The Beta test places 7 of the 10 students in the upper quartile and is 70% efficient. Two cases, however, are placed in the lower quartile by the Beta test. The Psychological Examination is 60% accurate placing 6 cases in the upper quartile, having a total misplacement of 4 as compared with 6 for the Alpha test and 3 for the Beta. The Composite places 7 in the upper quartile and none in the lower, and is, therefore, 70% accurate in placing the ten highest students. The total misplacement is 3. The Composite is first in predicting the ten highest students; the Beta test is second, while the Psychological Examination, and the Alpha test are third and fourth, respectively.

**Quartile comparison between the averages of the ten lowest students and the mental test composite and gross scores**
<table>
<thead>
<tr>
<th>Mental Test</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Coefficient of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.C. Form Alpha</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>.40</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.S.C. Form Beta</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>.70</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>.60</td>
</tr>
<tr>
<td>Examination (gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>.70</td>
</tr>
</tbody>
</table>

(10 cases)
(Table 15). The Alpha test is 50% efficient in predicting the quartile position of the ten lowest students. This test places 2 cases in each of the second and third quartiles and 1 in the upper quartile. The Beta test places 3 cases in the lower quartile and is therefore but 30% accurate. Five cases are found in the second quartile, 2 in the third quartile, while none are in the upper quartile. The Psychological Examination places 5 cases in the lower quartile; 2 cases both in the second and fourth quartiles and 1 case in the third quartile. This test is 50% efficient. The Composite seems to be the most accurate in predicting the quartile position of the ten lowest students. This test is 50% efficient, placing 5 cases in the lower quartile, 3 in the second and 1 in each of the other two quartiles. The Composite ranks first in prediction with the Alpha test slightly better than the Psychological Examination.

Summary and Interpretation. The results of the quartile analysis indicate:

(a) that the Composite predicts the relative position within a quartile the best; the Psychological Examination is second and the Alpha (43) and Beta tests are third and fourth in that order.

(b) that of the three mental tests used in this study the Beta test is most efficient in predicting "good"
<table>
<thead>
<tr>
<th>Mental Test</th>
<th>Fourth Quartile</th>
<th>Third Quartile</th>
<th>Second Quartile</th>
<th>First Quartile</th>
<th>Coefficient of Correspondence</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.S.C. Form Alpha</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>.50</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.S.C. Form Beta</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>.30</td>
</tr>
<tr>
<td>(gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>.50</td>
</tr>
<tr>
<td>Examination (gross)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>.50</td>
</tr>
</tbody>
</table>
students; the Alpha test ranks second, while the Psychological Examination is third. 
(c) that of the three tests used, the Alpha test seems to be the highest in efficiency in predicting "poor" students; the Psychological Examination ranks second, with the Beta test last. 
(d) that the Composite picks upper quartile students more efficiently than the three mental tests but is less accurate in predicting "poor" students than the "learning" test based primarily upon sense material. 
(e) that the Composite is the most efficient in predicting first term failures; the Psychological Examination is second, while the Alpha and Beta tests follow in that order. 
(f) that the Composite is first in predicting the ten highest students; the Beta test is second, and the Alpha test and the Psychological Examination are third and fourth, respectively. 
(g) that the Composite ranks first in the prediction of the ten lowest students with the Alpha test slightly better than the Psychological Examination, which in turn is more accurate than the Beta test. 

The results of the percentile analysis have little practical value when compared with an absolute standard. Substantial progress has, however, been made over the existing standards.
CHAPTER VI
SUMMARY AND CONCLUSIONS

The purpose of this study is to determine the most valid available test for use in predicting the academic success of college freshmen. The test based on recognition and recall was the Psychological Examination. Two tests based primarily upon ability to learn were used, namely, the Massachusetts State College Scholastic Aptitude Tests, Form Alpha and Beta. The nonsense material of the Beta replaces the sense material of the Alpha. Subject to limitations, the comparative efficiency of these tests in predicting academic success for the first term of the 1932-1933 academic year is determined here.

SUMMARY

Results of the Preliminary Analysis. A qualitative account of the frequency distributions of instructors' marks for the first and second terms shows (a) that the first and second term average marks tend to approximate the normal-frequency curve, (b) that with few exceptions the distributions of the term marks are "irregular" or abnormally skewed. There are also discrepancies revealed in the composite, gross and individual score frequency distributions.

Results of the Secondary Analysis. The Composite is the
most valid general measure of academic success. Of the three tests used in this study, the Psychological Examination, based on recognition and recall is slightly more valid than the test based upon the "ability to learn" sense material and the test based upon the "ability to learn" nonsense material. In spite of the fact, that some of the coefficients of correlation obtained between the gross scores and the first term marks are significant, most of them show that the tests are of very little prognostic value. In no instance do any of the correlations secured among the individual scores of the Massachusetts State College Scholastic Aptitude Test, Form Beta and the first term average marks show an index above the normal. Accurate prediction using the individual scores of the Beta test is therefore improbable.

Results of the Percentile Interpretation. The results obtained by means of quartile comparisons show that the Beta test is the most efficient in upper fourth average mark placement. The Alpha test is the most valid in selecting lower quartile students. The Psychological Examination is the most efficient in predicting first term failures. The Beta test places the ten highest students most accurately while the Alpha test is first in placing the lowest ten students.

The Beta Test. The conclusions reached in this study, in regard to the Massachusetts State College Scholastic Apti-
tude Test, Form Beta are based upon the test as it now stands. The principle of the test, namely, the "ability to learn nonsense material", is adversely criticized, when it is very possible that the construction of the Beta test itself is at fault; e.g., Section V of the test is far too difficult. When all students receiving zero in this section are eliminated and the remaining students' scores are correlated with the first term average marks, the coefficient of correlation is .372 ± .035, which is higher than the corresponding correlation when all Beta test scores are correlated with first term average marks (r = .305 ± .035). Section V should be made easier in order to give some indication as regards to the range, or extent of the difficulty in this section. For, obviously, it is impossible to rank students receiving a zero score. The tests and the principle underlying the test have been considered, in this study, as though they were of equal structural validity.

CONCLUSIONS

The principal conclusion to be drawn from this investigation is that the test based upon recognition and recall is superior to either of the tests based upon "learning" ability. The Psychological Examination is slightly more valid as a general indicator of academic success than the Massachusetts
State College Scholastic Aptitude Test, Form Alpha, and is the most accurate in predicting first term failures. The Beta test, based primarily upon the ability to learn nonsense material is not as valid as its "parent" test based upon the "ability" to learn sense material. The writer suggests that the most valid sections of the Beta test be incorporated into the Alpha test. It is significant that the composite of the gross scores is the most valid as a prognostic indicator. The Composite is superior in nearly every respect to the mental tests. It predicts future academic success with 15% accuracy, in itself quite unsatisfactory, but significant when it is understood that this is an increase of better than 85% in prognostic efficiency over the "average" indices. This in itself should be sufficient reason for the use of the "battery" of tests.

The mental tests appear more valid than any other indicators available at the present time and are therefore worthy of more consideration in selecting prospective freshmen. It must be remembered, however, that the tests are not 100% efficient. If this is so, then some "good" students must be sacrificed with the "poor". The above results are by no means final or conclusive. Only after further experimentation and more extended researches can final conclusions be drawn.
STUDY SHEETS
SECTION I

Directions: Study thoroughly the drawing and the printed material on this sheet. You will be asked questions about it later. You will neither be asked to reproduce the drawing nor to spell the words.

Part A

--- pivot
--- distracte
--- basket disc
--- interne
--- latera
--- cornu
--- fibrilare
--- mesium
--- centrope
--- centralis
--- extrale
--- neocentrope
--- collaterals
--- basket cells
discu
--- mesa cell
--- fibrilates

Part B

1. The pivot is a fixed point about which the stock revolves.
2. The distracte is the primary bolus of the upper stock.
3. The basket disc supports the upper bolus.
4. The interne is the differential of the upper stock.
5. The latera separates the upper from the lower stock.
6. The cornu is the granular core of the lower stock.
7. The fibrilare is an insulating sheath.
8. The mesium is a thin fibrous membrane.
9. The centrope is the middle segment of the lower stock.
10. The centralis is a short cylindrical reinforcement.
11. The extrale is the outermost covering of the lower portion.
12. The collaterals are spiral-like indentures.
13. The basket cells contain a high degree of food yolk.
14. The discu is a wax-like core.
15. The mesa cell supports the lower cilia.
16. The fibrilates are the cilia of the lower stock.
17. The neocentrope is a narrow indenture on the lower stock.

Stop here
SECTION II

Directions: Study carefully the selections given below. You will be asked questions about them later. You will not be expected to commit the selections to memory.

PART A

Aristotle was born at Stagira, a Macedonian city some 200 miles north of Athens, in 384 B.C. His father was physician to Amyntas, King of Macedon and grandfather of Alexander the Great. One narrative represents Aristotle as squandering his patrimony in riotous living, joining the army to avoid starvation, returning home to practice medicine, and going to Athens at the age of 30 where he studied philosophy under Plato for possibly 20 years. In 344 Hermias a wealthy pupil of Aristotle invited him to his court and gave him a sister (or niece) in marriage. In 343 Philip, having succeeded Amyntas to the throne of Macedon, called Aristotle to be the tutor of his son Alexander then a wild youth of 13. This position he held for three years with marked success. In 335 he established a school in Athens called the Lyceum which emphasized biology and natural science. Alexander assisted Aristotle in research by having his men collect specimens for him and by giving him 800 talents which is equal to about $4,000,000. The almost complete lack of equipment made scientific experimentation very difficult and the best he could do was to achieve almost universal and continuous observations. Aristotle possibly wrote 1000 volumes covering various phases of Logic, Science, Esthetics and Philosophy. After the death of Alexander in 323, he was accused by the patriotic party of favoring the political pretensions of Macedon, and was compelled to go into exile on the island of Euboea where he died in 322.

PART B

The gods immortal, as by law disposed,
First venerate, and reverence the oath:
Then to the noble heroes, and the powers
Beneath the earth, do homage with just rites.
Thy parents honor and thy nearest kin,
And from the rest choose friends on virtue's scale.
To gentle words and kindly deeds give way,
Nor hate thy friend for any slight offence.
Bear all thou canst; for Can dwells nigh to Must.
What follow learn to rule:
The belly first, then sleep and lust and wrath.
Do nothing base with others or alone:
But most of all thyself in reverence hold.
Then practise justice both in deed and word,
Nor let thyself wax thoughtless about aught:
But know that death's the common lot of all.
Be not untimely wasteful of thy wealth,
Like vulgar men, nor yet illiberal.
In all things moderation answers best.
Do things that profit thee: think ere thou act.
Let never sleep thy drowsy eyelids greet,
Till thou hast pondered each act of the day:
'Wherein have I transgressed? That have I done?
What duty shunned?'—beginning from the first,
Unto the last. Then grieve and fear for what
Was basely done; but in the good rejoice.
Massachusetts State College
Scholastic Aptitude Test

FOR COLLEGE FRESHMEN
Prepared by H. M. Glick and Alfred H. Holway.

<table>
<thead>
<tr>
<th>Name</th>
<th>(Last name)</th>
<th>(Given names or initials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Last school attended</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I</td>
</tr>
<tr>
<td>Section II</td>
</tr>
<tr>
<td>Section III</td>
</tr>
<tr>
<td>Section IV</td>
</tr>
<tr>
<td>Section V</td>
</tr>
<tr>
<td>Section VI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gross Score</th>
</tr>
</thead>
</table>
Directions (Part A).

Here is the drawing you studied; the parts are numbered and the names of the parts are at the right of the drawing. You are to copy the number of each part in the parentheses after the name of that part. Example: Number 1 is the pivot, so 1 is placed in the parentheses after pivot. Do nothing with the names of the parts which do not belong to this drawing.

Pivot
Centrope
Cornu
Collaterals
Meta cells
Discu
Fibrilare
Fibrils
Fibrilates
Basket cells
Mesa cell
Extrale
Basket disc
Centralis
Interne
Distrate
Latera
Medium
Mesalare
Neocentrope

Do not stop. Go to next sheet without further instructions.
Section I (continued)
Part B

Directions: Below are the definitions which you studied with the terms defined left out. The terms defined are among the list of terms below. You are to copy the number of the definition in the parentheses after the term which the definition best defines. Example: Definition number 1 defines pivot, so 1 is placed in the parentheses after pivot. Do nothing with the terms in the list which are not defined by any of the definitions.

1. The _____ is a fixed point about which the stock revolves.
2. The _____ is the primary bolus of the upper stock.
3. The _____ supports the upper bolus.
4. The _____ is the differential of the upper stock.
5. The _____ separates the upper from the lower stock.
6. The _____ is the granular core of the lower stock.
7. The _____ is an insulating sheath.
8. The _____ is a thin fibrous membrane.
9. The _____ is the middle segment of the lower stock.
10. The _____ is a short cylindrical reinforcement.
11. The _____ is the outermost covering of the lower portion.
12. The _____ are spiral-like indentures.
13. The _____ contain a high degree of food yolk.
14. The _____ is a wax-like core.
15. The _____ supports the lower cilia.
16. The _____ are the cilia of the lower stock.
17. The _____ is a narrow indenture on the lower stock.

Pivot .......................(1)  Collaterals .......................( )
Centrope ....................( )  Fibrilare .......................( )
Discu .........................( )  Basket disc .......................( )
Noocentrope ..................( )  Latera ..........................( )
Extrale .......................( )  Fibrilates .......................( )
Fibrils ........................( )  Mesalare .......................( )
Mesium ........................( )  Centralis .......................( )
Meta cells ....................( )  Distrate .........................( )
Basket cells ..................( )  Interne .........................( )
Cornu ..........................( )  Mesa cell .......................( )

Stop here.
Section II

Directions: One this sheet we have a vocabulary, some rules and some sample sentences of an artificial language. On the opposite page are some English sentences and just beneath each is its translation into the artificial language.

You are to study the English sentences and then try to memorize the vocabulary and forms on this sheet. Do not consult the English language, but write the word on the line and remember it. Then consult the translation on this sheet and draw a line through every word which is incorrectly translated. If correctly translated words are marked, they will count against you.

VOCABULARY

I—j
je
he
ku

at
the
jk

recall
noi

live
par

give
ok

lines
boy

book
link

statement
dad

home
nol

long
sl

bitter
chi

difficult
chi

large
kun

af

So—di

RULES:

1. Plurals are formed by adding "x";
   Examples: knox—knux

2. Past time is indicated by placing "r" before the verb;
   Examples: gave—arox

3. Opposites are formed by adding "x" before the noun;
   Examples: him—obux

4. The objective case is indicated by placing "r" before the noun or pronoun;
   Examples: him—obux

Samples (The incorrect translations are marked):

A. I gave the book to you.
   B. I arok the oblik to je.
Section II (Continued)

1. I gave the book to him.
    J arok uk oblik ig kux.

2. He gives the book to me.
    Ku ok il lik ig obj.

3. He lives at home.
    Ku par jik nol.

4. The medicine is bitter.
    Il obdem uk lo.

5. The book is at home.
    Il lik uk jik nol.

6. The small book is easy.
    Il kuiok jik uk chik.

7. The statement is difficult.
    Il dad uk obchi.

8. The boy went home.
    Il ket aruk obnol.

9. He lived long.
    Ku obpar si.

10. He denied the statement.
    Ku arun il dad.

11. The book is small.
    Il lik uk arkin.

12. The medicine was sweet.
    Il dem aruk oblo.

13. The book was small.
    Il lik aruk kuiok.

14. He took the books.
    Ku aruk il lik.

15. Come to me.
    Di ig jx.

16. We went home.
    Jx ardi obnol.

17. The little girl died at home.
    Il kui obnes parok jik obnol.

18. The bad girl took the large book.
    Il sick hes arok il kui oblik.

19. He is giving the book to the girl.
    Uk ok il oblik ig il nes.

20. He forgot the long statement.
    Uk arnoi il si obdat.

21. The girl forgot the bitter medicine.
    Il nes arnoi il look obdem.

22. I recall the book was difficult.
    J noi il lik aruk chi.

23. He affirmed the book was easy.
    Ku arun il oblik aruk chik.

24. He took the medicine; he died.
    Ku arok il obdem; ku arparok.

25. He forgot the medicine was bitter.
    Ku arnoiok il obdem aruk oblo.

26. They gave the medicine to the girl.
    Kux arok il obdem ig il obnes.

Stop here.
Section III

Part A

Directions: Below is the first selection you read with some parentheses inserted indicating that some of the words and figures are left out. Copy the number of the word or figure from the list below in the parentheses where the word or figure has been left out. Some words in the list may be repeated and some words may not be used at all.

( ) was born at ( ), a Macedonia city some ( ) miles north of ( ), in 384 B.C. His ( ) was ( ) to ( ), King of ( ) and ( ) or Alexander the Great. One narrative represents ( ) as squandering his patrimony in riotous living, joining the ( ) to avoid starvation, returning home to practice ( ), and going to ( ) at the age of ( ) where he studied ( ) under ( ) for possibly ( ) years. In ( ) a wealthy pupil of ( ) invited him to his court and gave him a ( ) or ( ) in marriage. In 343 ( ), having succeeded ( ) to the throne of ( ), called ( ) to the ( ) of his ( ) then a wild youth of ( ). This position he held for three years with marked success. In ( ) he established a school in ( ) called the ( ) which emphasized ( ) and natural science. ( ) assisted ( ) in research by having his men collect ( ) for him and by giving him ( ) talents which is equal to about $4,000,000. The almost complete lack of equipment made scientific ( ) very difficult and the best he could do was to achieve almost universal and continuous ( ). Aristotle possibly wrote ( ) volumes covering various phases of ( ), ( ), ( ) and ( ). After the death of ( ) and ( ), he was accused by the patriotic party of favoring the political pretensions of ( ), and was compelled to go into ( ) on the island of ( ) where he died in ( ).

1. Corinth
2. Athens
3. academy
4. Esthetics
5. grandfather
6. teacher
7. exile
8. navy
9. physician
10. observation
11. son
12. mother
13. Logic
14. Aristotle
15. 20
16. plants
17. 322
18. banishment
19. 335
20. biology
21. Euboea
22. 344
23. apparatus
24. Macedon
25. Philosophy
26. prison
27. advisor
28. Science
29. 800
30. Stagira
31. Amyntas
32. uncle
33. medicine
34. niece
35. law
36. tutor
37. 950
38. sister
39. Hermias
40. 1000
41. father
42. Socrates
43. experimentation
44. daughter
45. demonstration
46. Philip
47. 30
48. equipment
49. army
50. 200
51. 10
52. Plato
53. Lyceum
54. 13
55. Alexander
56. specimens
57. 323

Do not stop. Go to next sheet without further instructions.
Section III (Continued)

Part B

Directions: Answer the following questions according to the ideas and thought expressed in the poem which you read. If a statement is true, check (✓) true; if it is false check false; if the poem doesn't say whether a statement is true or false, check didn't say. The sample is checked correctly.

Sample: 1. There is only one god.  

<table>
<thead>
<tr>
<th></th>
<th>true</th>
<th>false</th>
<th>didn't say</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Homage should be paid to heroes.</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. One should honor his brothers and sisters.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Friends should be chosen indiscriminately from one's kin.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. Gentleness and kindness are virtues.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Profanity is a trait of bad character.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. One should highly reverence himself.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Bodily appetites should be held under control.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Base conduct is permissible in private but not in public.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. One should never hate anyone.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10. Justice is the greatest virtue.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Some people will escape death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. In some things moderation is bad.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. One should not consider his own profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Never reflect on the past</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Never grieve over base acts.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Always follow conscience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Duty should not be shunned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Charity is the greatest thing in the world.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Money is the root of all evil.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Vulgar men waste their wealth.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Do not be miserly.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. All rejoicing is condemned.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Some powers are beneath the earth.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. It is more important to control one's body than one's wrath.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. One should bear all he can.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>26. Never think of death</td>
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<td>27. Evil men are not immortal</td>
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<tr>
<td>28. If deeds are just, one's words may be unjust.</td>
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<td>29. Fasting is a virtue.</td>
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Stop here
SECTION IV

Directions: This test is divided into Part A and Part B. In each part some facts and principles are stated, and these are followed by some problems. You are to study the facts and principles and then solve the problems. In each part the solution of the problem is based upon the facts and principles in the same part.

PART A

Facts and Principle - According to Aristotle, the velocity of falling bodies varies directly with their weight. For example, a five pound body falls five times as fast as a one pound body. On the basis of this theory solve the following problems:

Problems: (Figure on blank spaces of sheet)

1. If a five pound ball falls with a velocity of 25 feet per second, what will be the velocity of a nine pound ball? ( ) Ans.

2. If the velocity of a 10 pound ball is 40 feet per second, what will be the velocity of a five pound ball? ( ) Ans.

3. If an eight pound ball drops 40 feet in two seconds, how far will a ball of half the weight drop in twice the time? ( ) Ans.

4. If an object weighing 6 pounds falls 5 yards in 1 second, what is the weight of an object which falls 25 feet in 1 second? ( ) Ans.

5. Anchor "A" drops 10 feet in 2 seconds; anchor "B" weighs 10 pounds, and drops 25 feet in 1 second; what is the weight of anchor "A"? ( ) Ans.

6. If a 15 pound ballast falls with a speed of 10 yards per second, how many feet will a 25 pound ballast fall in one minute? ( ) Ans.

(W_1 = weight of lighter body; W_2 = weight of heavier body; V_1 = velocity of lighter body; and V_2 = velocity of heavier body.)

7. In terms of W_2, V_1 and V_2 evaluate W_1. ( ) Ans.

8. In terms of W_1, V_1 and V_2 evaluate W_2. ( ) Ans.

9. In terms of W_1, W_2 and V_2 evaluate V_1. ( ) Ans.

10. In terms of W_1, W_2 and V_1 evaluate V_2. ( ) Ans.

Do Not stop. Go to next sheet without further instructions.
Facts and Principles:

(1) X, Y, and Z are physical factors. When these are combined in the form 4x, 2y, and 3z, the resulting life force (L) has a numerical value of 10; i.e. 4x, 2y, 3z = 10. (This is the standard combination).

(2) The addition of each unit x factor decreases the life force 1 unit,

(3) The addition of each unit y factor increases the life force \(\frac{1}{2}\) unit,

(4) The addition of each unit z factor increases the life force \(\frac{1}{4}\) unit.

Sample problem: 10x, 4y, 9z = 62 \(\frac{1}{2}\) Ans. Here we have 6 more x's than in the standard combination which deducts 6 units from 10. We have 2 more y's than in the standard combination which adds 1 unit to 10. We have six more z's than in the standard combination which adds \(1\frac{1}{2}\) units to 10. Then we have \(10 - 6 + 1 + 1\frac{1}{2} = 6\frac{1}{2}\) Ans.

Problems.

1. 4x, 3y, 6z =
2. 15x, 9y, 11z =
3. 14x, 2y, 3z =
4. 20x, 8y, 3z =
5. 6x, 6y, 3z =
6. 10L, 2y, 3z =
7. 8x, 10L, 15z =
8. 12x, 14y, 11L =
9. 14L, 2y, 39z =
10. 13x, 7\(\frac{1}{2}\)y, 12L =
SECTION V.

Directions. This section is divided into Part A and Part B; each part contains some facts, principles, sample problems, and problems to be solved. Read the statements of fact, study the principles employed in the samples, and work out as many of the problems as you can in the time allowed. You may figure on the right side of the page.

Part A

The facts. In the first ten problems, the
number 1 indicates the process of division ( \( \div \) );
number 5 indicates multiplication ( \( \times \) );
number 6 indicates addition ( \( + \) );
number 9 indicates subtraction ( \( - \) ).

Sample (Reduce to lowest terms):
\[
\begin{align*}
275352185862093 &= \\
27 \times 3 \times 2 \div 8 \times 8 + 20 - 3 &= - \\
\frac{27 \times 3 \times 2}{8 \times 8 + 20 - 3} &= \frac{162}{81} = 2 \text{ Ans.}
\end{align*}
\]

Problems (Reduce to lowest terms):

a. \( 24585467185497 = \) ( ) Ans.
b. \( 72545818585453 = \) ( ) Ans.
c. \( 856889341226794 = \) ( ) Ans.
d. \( 27825418 = \) ( ) Ans.
e. \( 23418294 = \) ( ) Ans.
f. \( 72679417546497 = \) ( ) Ans.
g. \( 25354571754532 = \) ( ) Ans.
h. \( 367649412689494 = \) ( ) Ans.
i. \( 353549341758622987 = \) ( ) Ans.
j. \( 25362771894 = \) ( ) Ans.

Do not stop. Go to next sheet without further instructions.
Part B

Facts and Principles. 1. The process of reducing a general expression is called standardization.

2. Just as the sign + (plus) signifies addition, the sign * indicates standardization.

3. The following expression is a statement of the standardization equation:

\[ * \frac{x+y}{x+y} + \frac{x}{y} \]

Sample (Reduce by standard method):

\[ * 16 - 8 = \frac{16-8}{16+8} + \frac{16}{8} = \frac{8}{24} + \frac{16}{8} = \frac{1}{2} + 2 = 2\frac{1}{2} = \text{Ans.} \]

Problems (Reduce by standard method):

a. * \[ g + 4 = \]
   Ans.

b. * \[ 12 + 4 = \]
   Ans.

c. * \[ 16 + 2 = \]
   Ans.

d. * \[ 10 + 2 = \]
   Ans.

e. * \[ 16 + 8 = \]
   Ans.

f. * \[ 24 + 6 = \]
   Ans.

g. * \[ 48 + 16 = \]
   Ans.

h. * \[ a + b = \]
   Ans.

i. * \[ ab + c = \]
   Ans.

j. * \[ abc + dz = \]
   Ans.

You may use this space for figuring.

Stop here.
Section VI

Directions: Answer the questions on the following page according to the ideas directly expressed or implied in the following selection. If a statement is true, check (√) true; if it is false, check false; if the selection does not say if it is true or false, check doesn't say. Number 1 is checked correctly.

Whenever anything in nature seems to us ridiculous, absurd or evil, it is because we have but a partial knowledge of things, and are in the main ignorant of the order and coherence of nature as a whole, and because we want everything to be arranged according to the dictates of our own reason; although in fact, what our reason pronounces bad is not bad as regards the order and laws of universal nature, but only as regards the laws of our own nature taken separately. As for the terms good and bad, they indicate nothing positive considered in themselves. For one and the same thing can at the same time be good, bad, and indifferent. I do not attribute to nature either beauty or deformity, order or confusion. Only in relation to our imagination can things be called beautiful or ugly, well-order or confused.

......... Neither is mind material nor is matter mental; neither is the brain-process the cause, nor is it the effect of thought; nor are the two processes independent and parallel. For there are not two processes, and there are not two entities; there is but one process, seen now inwardly as thought, and now outwardly as motion; there is but one entity, seen now inwardly as mind, now outwardly as matter, but in reality an inextricable mixture and unity of both. Mind and body do not act upon each other, because they are not other, they are one. The body cannot determine the mind to think; nor the mind determine the body to remain in motion or at rest, or in any other state, for the simple reason that the decision of the mind, and the desire and determination of the body are one and the same thing.

SPINOZA.

Do not stop. Go to next sheet without further instructions.
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<tr>
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<tbody>
<tr>
<td>1. Some things in nature seem ridiculous.</td>
<td>true</td>
<td>false</td>
<td>doesn't say</td>
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<tr>
<td>2. Evil maybe due to ignorance.</td>
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<tr>
<td>3. Reason does not always give true knowledge.</td>
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<td>4. The Devil is the cause of evil.</td>
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<td>5. Good and evil are relative not absolute.</td>
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<td>6. Beauty does not exist outside the mind.</td>
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<td>7. What is evil to one may be good to another.</td>
<td>true</td>
<td>false</td>
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<tr>
<td>8. Nothing can be both good and evil at the same time.</td>
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<td>9. Evil is caused by human nature.</td>
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<td>10. Ugliness is inherent in the nature of things.</td>
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<td>11. All beauty comes from God.</td>
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<td>12. All beauty gives us pleasure.</td>
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<td>13. Confusion is caused by disturbances in the physical elements.</td>
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<td>14. Brain processes are the cause of mind.</td>
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<td>15. Mind is material substance.</td>
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<tr>
<td>16. Material substance is the product of mind.</td>
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<tr>
<td>17. Thought causes brain processes.</td>
<td>true</td>
<td>false</td>
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<td>18. Mind and matter are the same thing.</td>
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<td>19. Brain activity and mind are independent of each other.</td>
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<td>20. Mind and matter together form one substance called energy.</td>
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<tr>
<td>21. Mind is influenced by the fourth dimension.</td>
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<tr>
<td>22. Mind and matter do not act upon each other.</td>
<td>true</td>
<td>false</td>
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<td>23. Imagination causes mental fatigue.</td>
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<td>24. Strong minds are found in strong bodies.</td>
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<td>25. The mind cannot control the body.</td>
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<td>26. A definite body condition means definite mental condition.</td>
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<tr>
<td>27. Mind and matter comprise a single entity.</td>
<td>true</td>
<td>false</td>
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<tr>
<td>28. Electricity is both mind and matter.</td>
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<td>29. Gravity resembles mind more than matter.</td>
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<tr>
<td>30. The body and the mind are one.</td>
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REFERENCES

3. Ibid., p. 469.
4. The Binet test even with its various revisions is still faced with that difficulty, which has prevented universal usage.
7. Pintner, R., op. cit., p. 266.
9. Also called the Thurstone IV test.
19. Difficulty not in the sense of intellectual level but as being taught by an incompetent instructor or unnecessarily "padded".
20. Odell, C. W., op. cit., p. 36.
22. Yule, G. V., op. cit., p. 79.
24. Yule, G. V., op. cit., p. 79.
25. Cf. Tables 1, 2, 3, 4, pp. 15-18.
35. Holway, A. H., op. cit., Summary of Chapter I.
39. The Beta test has been given but one year. A study of this test extending over a number of years would provide the data necessary for more complete conclusions.
40. Odell, C. W., op. cit., p. 299.
41. The fourth quartile contains those students with averages of 77% or over.

42. The lower quartile includes those students with averages of 63 or below.

43. The writer is of the opinion that the Alpha test is not too reliable as a prognostic indicator. The results of this study do not coincide with the findings of Holway. A detailed study of this test over several years would undoubtedly settle the question of reliability.
ACKNOWLEDGMENTS

It is a pleasure to acknowledge my indebtedness for the initial inspiration for the undertaking to Dr. Harry N. Glick. I wish to express appreciation, also, to those others who by their suggestions and inspiration are largely responsible for whatever degree of success this work may have attained.
Approved by:

[Signatures]

Graduate Committee

Date: June 12, 1933