PREDICTING COLLEGE SUCCESS FROM MENTAL TEST SCORES AND CUMULATIVE SCHOLASTIC RECORDS

by

RALPH ALEXANDER IRWIN

B. S., Kansas State Agricultural College, 1928

A THESIS

submitted in partial fulfillment of the

requirements for the degree of

MASTER OF SCIENCE

KANSAS STATE AGRICULTURAL COLLEGE

1929

TABLE OF CONTENTS

INTRODUCTION

The increasing enrollment in American colleges and universities and the consequent greater range of ability, interests, and training of the students who seek a higher education have greatly increased the problems of administration. The student body of the American college today is recruited from all levels of social life. Some college students are studying automobiles and tractors. Others are studying the classics, or preparing for the professions. Many courses take only a few weeks. Others require ten years of work. The college is diversifying its program to meet the needs of practically every element of the American population. Every sort of diploma from doctor of philosophy to experts in every line of activity may be had at some

school. In other words, educators are attempting the realization of the ideal of an equal chance educationally for all. Even the highest of educational institutions have bent their energies toward providing training for all. Instead of setting standards which prospective students must pass before entering college the college has been lowering its standards to the level of those who seek admittance. The trend has been to fit the educational system to the needs of the people.

In recent years, educators, while recognizing that democracy demands education for all, realize also that the lack of generally accepted standards for college work lessens the value of a college diploma or degree. Educators have felt the need of differentiating between one degree and another. They survey the population that is clamoring for a higher education and realize that although the American constitution offers equal opportunity for all, not all are equal in ability, training, interests, or purpose. This brings to the college administrator the problem of determining what the student is fit for, whether he has greater chances of success in this course or in that course, what the possibilities are of his success in any kind of college work whatever, etc. Then too, there is the problem of wasted funds spent on students who do not fit in the studies they have taken up. Many colleges and universities have

problems similar to one described by Terman in Ben D. Wood's (1) "Measurement in Higher Education." Terman says, "One university of about 2,500 students and 1 1/2 million annual income spends more than a quarter of a million annually on students who are on probation or who later will be disqualified for poor scholarship. Actual test shows that about 80 per cent of the failing students in this university have a grade of intelligence which renders their failure in such a university practically inevitable."

One of the most recent and most promising developments rising out of the need for valid measurements of the ability and training of prospective college students has been the mental and educational test movement. Statistical methods have been applied to education and, since human abilities have been found to approximate the normal distribution curve statistical findings have been of the greatest value. Objective methods of measurement which are constant in their reliability and validity have been the goal.

Various objective measurements have been suggested and used for classifying students in college or for admitting students to college. Among these measurements are high school grades, mental test scores, achievement tests, interest tests, etc. Varying results have been found when these measurements have been put to the test of validity. Data have been compiled for this thesis with the purpose of

making comparative evaluations of various criteria for predicting college success, using the same group of students, and at the same time fitting the data to actual administrative problems. High school grades, mental test scores, and college grades are the measures discussed in this thesis. How much can we rely on high school grades for a criterion as to whether or not a student will be successful in college? How do high school grades compare in predictive value with the mental tests given to all freshmen entering the Kansas State Agricultural College? Are their predictive values increased when they are combined? Is only one semester of college work a fair trial for those who fail that first semester? The problem is to determine the best possible means available of predicting the ability of the student for any semester of college work.

METHOD

The data are based on the records of 208 college freshmen who entered the Division of Engineering of the Kansas State Agricultural College in 1922. With five exceptions all engineering freshmen whose high school grades were available and who took the Thorndike Intelligence Tests given that year and who made a record of at least eight semester

hours were included in the study.[1] This was done to keep the semester grades as nearly comparable as possible. All freshmen were required to take the intelligence tests that year and the high school grades were available in almost all cases, so it is assumed that this study includes all levels of ability of those who seek admittance to Kansas State Agricultural College as students of engineering. Since a number of students drop out each semester the predictions for each succeeding semester are necessarily based on smaller numbers of cases. Two hundred and eight freshmen who started are included. This number dwindles to 71, who took at least eight semesters of college work.

The high school grades were averaged from the high school transcripts sent to the registrar. The many varied systems of grading used by the high schools made it necessary to reduce them to some common scale. The scale chosen was a percentage scale with 70 as passing and 100 as a maximum. Grades from any high school using any other passing mark than 70 were changed to the 70-100 scale by interpolation. Thus an average of 80 in a school in which 75 is passing was changed to 76 on the 70-100 scale. The letter grades used by some schools were arranged on the scale in

1. If grades representing the proper standing of those students who dropped out before making sufficient records to be included in this study were available the correlation would be somewhat higher and would show all the predictive measures up to better advantage.

this manner; the range of 30, from 70 to 100, was divided into as many equal steps as there were letter grades in the grading system, and each letter grade earned by the student was assigned the median value of the division in which it fell. Most letter systems had four grades above failure. Failing grades were all assigned a value of 66.25, one step below the lowest passing grade. All subjects taken in high school were included in the averages except music and physical education, and the grades earned in each subject were weighted according to the units allowed them by the high schools in which the grades were made. This differed in a few cases with the units allowed by the registrar for college entrance, but usually the difference was caused by the student's failure to complete enough of the subject to be counted as worthy of entrance credit. For instance, one half year of Latin is not counted by the registrar, but the grade in that half year was considered to have some predictive value, so was included in the averages used in this thesis. When the grades were all averaged it was found that the lowest average was 75 and the highest was 95.

The college grades at the Kansas State Agricultural College at that time were in order of excellence E, G, M, P, and F. They were assigned numerical values as follows: E 5, G 4, M 3, P 2, F 1. Then the total number of points was divided by the number of semester hours to get the

weighted semester average. This was done for each semester that the student was in college. If a student were out of college for a semester or two, his average in the semester in which he returned was labelled second semester average or third semester average, etc., as the case happened to be, without leaving any blank space to break a continuous record. All grades earned by the student were included except those in music, military training, and physical education, which in other studies have been shown to reduce correlations.

After the semester averages were computed they were combined so that for each student there was a grade average of his whole record up to and including any semester of his college career. This average is called the cumulative average as distinct from the semester average. Semester averages ranged from 1.00 to 5.00. The cumulative averages ranged from 1.22 to 4.68.

The mental tests given were the Thorndike Intelligence Examination for High School Graduates, tests which took approximately three hours to give. The raw scores of these tests which were used in all statistical calculations ranged from 18 to 120.

With these variables then, separate semester grades, cumulative college grades, high school grades, and Thorndike mental test scores, correlations were calculated, including a number of multiple correlations which measured the predic-

tive value of various combinations of two variables for any semester of grades.

The formula for zero order correlations used was that explained by Leonard P. Ayres in Volume I of the Journal of Educational Research. (2) The formula is as follows:

$$r = \frac{\Sigma fRS - Av.S \times RT}{\sqrt{(SST - ST \times Av.S)(RRT - RT \times Av.R)}}$$

R equals the deviation of the R variables from 0 as the origin. S equals the deviation of the S variables from 0 as the origin. T equals the number of cases. RT equals the summation of the number of R measures in a class interval times their deviation from 0 as the mean. Likewise ST equals the summation of the S measures in a class interval times their deviation from 0 as the origin. Av.R equals RT divided by T. Av. S equals ST divided by T. f equals the number of cases in any cell of the distribution table. ΣfRS equals the summation of the f's times the R deviations times the S deviations.

The formula used for multiple correlations with three variables was presented by Lowell Kelly in Volumn 20 of the Journal of Educational Psychology. (3)

$$R_{1(23)} = \sqrt{\frac{r_{12}^2 + r_{13}^2 - 2(r_{12} \cdot r_{13} \cdot r_{23})}{1 - r_{23}^2}}$$

For correlation purposes the high school grades, mental test scores, and college grades were divided into class intervals. The high school grades were divided into eleven intervals by including two points in one interval. Thus

TABLE I. ZERO ORDER CORRELATIONS

	1st Sem (309)	2nd Sem (177)	3rd Sem (124)	4th Sem (105)	5th Sem (69)	6th Sem (61)	7th Sem (74)	8th Sem (71)	4th Cum (105)	8th Cum (71)	H.S. Ave. (208)
Thorndike	.6124	.5700	.4262	.4312	.3976	.2377	.3925	.3325	.5436	.4735	.4725
H.S. Grades	.4900	.4909	.4076	.3784	.2954	.1149	.3067	.2885	.5672	.4194	
1st Sem		.7495	.5910	.7024	.4551	.4296	.3826	.4628	.8266	.7700	
2nd Sem			.6908								
3rd Sem				.7523							
4th Sem					.6825						
5th Sem						.5424					
6th Sem							.5980				
7th Sem								.7576			
2nd Cum			.5967	.7150	.5546	.4616	.5897	.4213			
3rd Cum				.7815	.6286	.5384	.4976	.5495			
4th Cum					.7909	.5624	.5611	.5489		.8500	
5th Cum						.5908	.5665	.6103			
6th Cum							.6385	.6499			
7th Cum								.6989			

The number of cases in each correlation is indicated by the number in parenthesis at the top of each column. The predictive measures are listed in the vertical column at the side. The criteria are listed horizontally at the top.

TABLE I. CONCLUDED

	H.S. Ave.	1st Cum	2nd Cum	3rd Cum	4th Cum	5th Cum	6th Cum	7th Cum
Here Second Semester								
Thorndike (172)	.4528	.5893						
H.S. Grades (172)		.4964						
Here Third Semester								
Thorndike (124)	.3965	.5658	.4100					
H.S. Average(124)		.4151	.4401					
Here Fourth Semester								
Thorndike (105)	.4147	.5296	.4295	.6786				
H.S. Average(105)		.3626	.3767	.4089				
Here Fifth Semester								
Thorndike (89)	.3918	.5962	.5153	.5905	.6233			
H.S. Average (89)		.3463	.3724	.3841	.3928			
Here Sixth Semester								
Thorndike (81)	.4252	.5682	.4571	.5728	.6396	.5594		
H.S. Average (81)		.3726	.3597	.3780	.3881	.3847		
Here Seventh Semester								
Thorndike (74)	.4729	.6136	.6113	.5531	.6210	.5839	.5327	
H.S. Average (74)		.4306	.4151	.4282	.4722	.4473	.4141	
Here Eighth Semester								
Thorndike (71)	.5095	.5686	.4265	.5673	.6133	.5714	.5190	.4886
H.S. Average (71)		.4777	.4262	.4667	.4897	.4932	.4602	.4272

TABLE II. MULTIPLE CORRELATIONS

	1st Sem	2nd Sem	3rd Sem	4th Sem	5th Sem	6th Sem	7th Sem	8th Sem
H.S. and Thorndike	.6877	.6265	.4990	.4902	.4256	.2322	.4156	.3601
Thorndike and 1st Sem		.7656	.6010	.7059	.4815	.4298	.4316	.4717
H.S. and 1st Sem		.7619	.6172	.7078	.4782	.4323	.4137	.4688
H.S. and 2nd Cum			.6290	.7247	.5627	.4648	.5936	.4582
Thorndike and 2nd Cum			.6182	.7281	.5697	.4632	.5911	.4539
Thorndike and 3rd Cum				.7930				
H.S. and 3rd Cum				.7857				
Thorndike and 4th Cum					.8002			
H.S. and 4th Cum					.7906			
Thorndike and 5th Cum						.6013		
H.S. and 5th Cum						.6032		
Thorndike and 6th Cum							.6416	
H.S. and 6th Cum							.6402	
Thorndike and 7th Cum								.6989
H.S. and 7th Cum								.6989

averages of 75 and 76 fell in the same interval. The mental test scores were divided into intervals of five points, making 22 intervals. The college grades were divided into twelve intervals, each step from one whole number to the next being divided into three steps; thus, 1.00-1.33, 1.34-1.66, and 1.00-1.99, etc. In a first trial the high school grades were divided into steps of five, with only five intervals. This resulted in lower correlations than in using smaller class intervals.

DISCUSSION OF RESULTS

1. The first correlations were with first semester grades as predicted from mental test scores and high school grades separately and combined into one predictive measure by multiple correlation. For the 208 freshmen who entered in 1922 the correlation between high school grades and first semester weighted averages was .4900. Between the Thorndike scores and first semester averages there was a correlation of .6124, a distinct advantage of the three hour test over four years of high school work. These results are not consistent with the results of those who entered in 1923 and 1924 though. In 1923 the correlation between high school grades and first semester college grades was .4072 and in 1924 it was .5992, which shows that stand-

ards of grading in high schools vary greatly. Other studies made at Kansas State Agricultural College show the same lack of consistency using correlations with high school grades. For 90 freshmen entering the Division of Agriculture in 1921 Strickland (4) found a correlation of .328 between high school averages and first semester college averages. W. W. Charters in the May, 1929 number of the Educational Research Bulletin (5) cites an unpublished bulletin prepared under the direction of the Junior Council of the Ohio State University to the effect that high school marks have proved to be of little significance in that institution as predictors of continuance at college.

The Thorndike tests given in 1923 and in 1924 were supposedly equated with each other and with that given in 1922, but the correlation in 1923 with first semester grades was .5176 and in 1924 was .5308, a drop from the .6124 of the 1922 class. Possibly the tests were not well enough equated or possibly the freshman classes of these separate years were different in general make-up. The outstanding fact though is that the correlations of Thorndike scores with first semester grades show a distinct superiority in predictive value to the four years of high school grades, although high school grades are becoming more standardized each year and in general are yielding better predictive value.

When the predictive correlations from Thorndike and High School grades were combined by multiple correlation to show the combined predictive value there was a distinct rise for the 1922 freshmen. The correlation was raised to .6877, a fact which justifies the college in averaging all high school grades and giving mental tests and combining the results for administrative purposes.[1]

2. Correlations of both the high school grades and of the mental tests scores with each succeeding separate semester average fell off gradually from the first semester to the 6th semester, when both predictive measures gave extremely low correlations, .2315 for the Thorndike scores and .1149 for high school grades. The correlations are as follows:

TABLE IV. ZERO-ORDER CORRELATIONS WITH SINGLE SEMESTER AVERAGES

Semester	Thorndike	High School Average	Multiple
1	.6124	.4900	.6877
2	.5700	.4909	.6265
3	.4262	.4076	.4991
4	.4312	.3784	.4902
5	.3976	.2954	.4266
6	.2315	.1149	.2322
7	.3925	.3067	.4156
8	.3325	.2885	.3608

1. Kansas State Agricultural College, the University of Minnesota, and other institutions are combining high school grades and mental test scores for predictive purposes.

In each of the above sets of correlations there is thus a gradual tapering off until the 6th semester when there is a very low correlation. No clear-cut reason can be assigned to this very low correlation the 6th semester in all cases unless it is that many students then are taking four and five hour courses who had had only courses of a smaller number of semester hours previously. The greater number of semester hours might tend to make the grading system less flexible as a measure of the student's actual ability. The low correlations in the sixth semester are not found in all other studies. From a similar study made last fall on 69 cases from all divisions of the college there were low correlations in the fourth semester, which would tend to show that there is nothing inherent in the fact that the student was taking his sixth semester of work that would make for low correlations. It must be recognized, too, that the above correlations are with different numbers of cases because of the many dropping out each semester. The number of cases ranges from 208 the first semester to 71 the 8th semester.

The decreasing correlation from semester to semester is probably due to the fact that the weaker students are eliminated and there is left a smaller range of talent and all students get more nearly the same grades the eighth se-

master than the first. Some psychologists say that abilities diverge clear through college, but whether they do or not the college grading system is not elastic enough to measure these divergent abilities.

3. In contrast with the above gradual lowering of the predictive value of high school grades, Thorndike scores, and the two combined for succeeding semesters of college work it may be noted by observing Table II, page 12, that correlations between Thorndike or high school grades with succeeding semesters of cumulative grades for the same cases all the way through college shows a rise in correlation up to the fourth semester and then only a small comparative drop the next three semesters. These correlations were calculated for the purpose of predicting for succeeding semesters so the correlations of Thorndike and high school grades with the eight semesters of cumulative grades is not included. It will be noted that after the third semester the correlations with cumulative grades are higher than with semester grades, which points to the fact that single semester averages of grades are not the best criteria for judging the value of predictive measures and that it would be impossible to prove any predictive measure whatsoever a perfect measure. According to Wood (1) "For the present we must look upon .70 as the limit of the correlations which

may be secured between any criterion for admission and academic achievement as now measured."

The fourth semester cumulative grades give the highest correlations with the predictive measures which would indicate the entrance of a greater number of factors the second two years than the first two years other than the factors inherent in a student's training or ability. Of course this is based on the assumption that the Thorndike scores measure inherent ability to some extent, and that high school grades measure training.

One interesting fact is that the correlation between Thorndike and the fourth semester cumulative averages is .07 higher for the 71 students who were here the eight semesters than for the 106 who were here only four semesters. The exact reversal is true of the high school grades. The Thorndike correlations are .5438 and .6133. The high school correlations are .5972 and .4897. Assuming that mental tests measure a student best when he is performing at a maximum capacity the foregoing results show that many students drop out of college the second two years for reasons other than inherent inability to carry on the harder work of the last two years of college.

4. First semester grades give consistently higher correlations with succeeding semesters than either high school

grades or Thorndike scores.

TABLE V. ZERO-ORDER CORRELATIONS BETWEEN FIRST SEMESTER GRADE AVERAGES AND SUCCEEDING SEMESTERS OF GRADE AVERAGES

2nd	.7495
3rd	.5900
4th	.7024
5th	.4551
6th	.4296
7th	.3826
8th	.4628

This predictive measure gives the lowest correlation with the seventh semester, although the sixth semester is also low. The fact, though, that first semester grades do not give the same results as the high school grades and Thorndike scores indicates that whatever the disturbing factor during the sixth semester it is probably inherent in college life and not in any special disability of the student.

Since first semester and second semester correlate to the extent of .7495 it may be inferred that no better criteria could be found for second semester grades, because it exceeds the limit generally set as the maximum correlations possible for any predictive measure. Shuttleworth of Iowa says, "If this correlation is .75 it is usually assumed that the predictions cannot be higher." (6) Shuttleworth found a correlation of .72 between first and second semester grades.

5. From Table II, page 12, it may be seen that combinations of the three variables so far discussed show that first semester grades combined with either high school grades or Thorndike scores give practically the same multiple correlations. This is true in comparing the combinations for predicting any semester of grades. Either combination is better than the combination of high school grades and Thorndike scores. By comparison with Table I, page 10, though, it will be seen also that the increased predictive value from any two variables over first semester grades alone is practically negligible. Only one or two hundredths correlation points (.01 or .02) are added by the multiple correlation process. Because of the small increase found by combining the two it was thought not worth while to combine the three variables for the prediction of the fourth.

When Thorndike scores and first semester grades were combined there was a substantial increase in predictive value over the single measures but the combined correlation was in no case higher than the first semester grades used as a single measure. Of course, in predicting for the first semester or for any other semester when the first semester grades are not available it would be a worth while procedure to combine the high school grades and Thorndike scores into one predictive measure.

6. The best single predictive measures found were the cumulative grades up to and including the semester before the one for which a prediction was desired. Following are the correlations between cumulative grades and the succeeding semester averages:

TABLE VI. ZERO-ORDER CORRELATIONS BETWEEN CUMULATIVE GRADES AND THE SUCCEEDING SEMESTER

1st Sem x 2nd Sem	.7496
2nd Cum x 3rd Sem	.5967
3rd Cum x 4th Sem	.7815
4th Cum x 5th Sem	.7909
5th Cum x 6th Sem	.5906
6th Cum x 7th Sem	.6385
7th Cum x 8th Sem	.6989

Again the sixth semester gives the lowest correlation, but as in all other cases except two the cumulative average gives a better correlation than any other single measure. The exceptions are the case of prediction for the 8th semester, where the seventh semester grades were found to be the best predictive measure, and the prediction for the third semester, where the first semester grade average is the best predictive measure.

7. When either the Thorndike or high school grades are combined in multiple correlation with cumulative college grades the added correlation possible is negligible in all cases except for predicting the third semester from the second cumulative and either the high school grades or Thorndike, and here even the increase was only from .59 to .61

using the high school grades and from .59 to .62 using the Thorndike scores. Apparently it is not necessary to resort to multiple correlation or regression equations to get a very near approach to any semester of grades.

The multiple correlation method finds its greatest justification in predicting for semester grades from combined high school grades and Thorndike scores. Thorndike scores correlated with the second semester gives .5700 and high school grades with the second semester gives .4909. Combined the correlation is raised to .6265. Similar increases are noted in other semesters, though the multiples show smaller advantages.

For the second semester the first semester grades seem to be the best criterion. For other semesters though there is a small increase by using first semester grades combined with Thorndike scores, but not so much increase using high school grades.

8. Since it was found that the previous semester's cumulative grade average was the best predictive measure for any semester of grades the single semester averages were correlated with the succeeding semester averages. This gave the best predictive measure with the exception of the cumulative averages. The correlations ranged from .03 to .11 lower than the correlations using the cumulative averages as the predictive measure. In fact the semester averages were

not of much higher predictive value than the cumulative averages two semesters preceding the semester used as the criterion. Since it takes only a little extra time to figure cumulative averages when semester averages are known there is little reason for using single semester averages instead of cumulative averages which have higher validity.

9. One more phase of predictive measures was investigated, and it gives the best prediction of all, but is beset with statistical difficulties. In correlating first semester grades with fourth semester cumulative grades there is a correlation of .8266 and first semester with eighth cumulativesgives .7700. However, the fourth and eighth cumulative averages include the first semester also. A similar case is that in which there is a correlation of .8500 between fourth semester cumulative grades and eighth semester cumulative grades. The correlations are valuable though in showing just what the students' final averages will be by knowing the first semester average or the average of the first four semesters of work. Garrett, in his text, "Statistics in Psychology and Education," (7) gives a formula based on the coefficient of alienation by which the amount of correlation added to a correlation coefficient because of overlapping factors can be determined. This formu-

la is, $r^2 = \frac{n_c}{n_a + n_c}$ where n_c is the proportion of common elements and n_a is the proportion of elements in the second variable not included in the first. This gives the correlation caused by overlapping. However, this cannot be subtracted directly from a correlation coefficient as actually found, but index numbers can be subtracted from one another. The coefficient of alienation is an index of the advantage of a predictive measure over pure chance or a mere guess. By subtracting the index due to common elements in both variables from the index of the actual correlation an index is obtained for the corrected correlation. A table of predictive indices is found in "Experimentation and Measurement in Religious Education," by Goodwin B. Watson. (8) The index number is one minus the coefficient of alienation. By this method then, knowing the correlation between fourth semester cumulative grades and eighth semester cumulative grades it is possible to predict the second two years of grades from the first two years.

In testing out the above procedure the corrected coefficient for the correlation of .8500 between the fourth and eighth semesters of cumulative grades was .5600. Putting the data to an empirical test an actual correlation of .5924 was found. This was found by assuming that the

student took the same number of credit hours the second two years as he did the first. Upon checking up on this assumption it was found that the average number of credit hours taken the first semester was 64.01 and the average taken the second semester was 62.93. Obviously it makes little or no difference whether the actual number of hours is substituted in Garrett's formula or whether the first two years of study by the student is taken to be equal in amount to the last two years.

In a second test of the method described the correlation between the first semester and fourth semester cumulative grades was .8266. When corrected by the formula the correlation was .7200. When tried empirically the actual correlation was .7395. The overlapping was found to be almost exactly one-fourth. The formulae would give closer approximations to the actual correlations if the tables used had been carried out to more than two decimal places. As they are though the tables give correlations close enough for practical use.

SUMMARY

The results of this study show that the cumulative average, up to the preceding semester, is the best single predictive measure for any semester of grades and combining this measure with any other measure by multiple correlation

does not increase the predictive value of the former. The second best measure is the semester average just before the semester to be predicted. High school grades are the poorest predictive measures though they are of value when combined with Thorndike mental test scores, especially for the first semester, when this combination is the best combination available. In fact this combination approaches the limit of perfection (correlations of .70 to .75) generally accepted as the goal by psychologists because of the imperfections of the criteria. Thorndike mental test scores are the best single predictive measures for the first semester of grades. It must not be inferred, however, that because any measure is exceeded in predictive value by any other predictive measure that the former is of no value. Any number of predictive measures is of value so long as they can be shown to measure different abilities. It is generally conceded that mental test scores and college grades do not measure exactly the same abilities. Different measures are valuable in diagnosing individual cases to see wherein a student fails, whether it is because of low intelligence or because of some other factor measured by college grades but not by intelligence tests. Other such examples could be given. The final conclusion is that predictive measures of the highest value to be expected under the present grading systems are available and that they are of great value both to the student and to the administrator when rightly used.

ACKNOWLEDGMENT

The suggestions which led to the selection of this problem for a thesis came from Dr. J. C. Peterson, Professor of Psychology at Kansas State Agricultural College. I am indebted to him for his constant interest and many suggestions.

BIBLIOGRAPHY

1. Woods, Ben D.
Measurement in Higher Education. World Book Co., New York, 1923.

2. Ayres, Leonard P.
"A Shorter Method for Computing the Coefficient of Correlation". Journal of Educational Research, Vol. I, March, 1920.

3. Kelly, E. Lowell.
"The Relationship Between the Techniques of Partial Correlation and Path Techniques". The Journal of Educational Psychology, Vol. XX, Feb. 1929.

4. Strickland, V. L.
"Relative Levels of Intelligence in College and High School". Kansas State Agricultural College Bulletin, Manhattan, Kansas, 1926.

5. Charters, W. W.
"Predicting Success in College". Educational Research Bulletin, Vol. VIII, No. 9, May 1, 1929.

6. Shuttleworth, Frank K.
"The Measurement of the Character and Environmental Factors Involved in Scholastic Success". University of Iowa Studies, Iowa City, Iowa, 1927.

7. Garrett, H. E.
"Statistics in Psychology and Education". Longmans, New York, 1925.

8. Watson, Goodwin B.
Experimentation and Measurement in Religious Education, Association Press, New York, 1927.