THE PREDICTIVE VALUE OF THE STANFORD SCIENTIFIC AND THE ENGINEERING AND PHYSICAL SCIENCE APTITUDE TESTS

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TABLE OF CONTENTS

LIST OF TABLES

THE PREDICTIVE VALUE OF THE STANFORD SCIENTIFIC AND THE ENGINEERING AND PHYSICAL SCIENCE APTITUDE TESTS

CHAPTER I

INTRODUCTION

The testing movement is now in a period of phenomenal growth. Tests are being used more widely in schools and industry as a result, in part, of increased assistance and emphasis by agencies of the federal government. As is true of all relatively new devices, the rapid expansion of this measuring technique has its dangers. Tests are often constructed and circulated before adequate checks have been made on their validity, reliability and their usefulness for specific purposes. The rapid mobilization of personnel for World War II required the immediate use of tests and caused many to be devised and standardized without sufficient work having been done on them. Many were in new fields of measurement and were frankly experimental. Also, demands for various types of measurements have stimulated the development of tests on a commercial rather than a scientific basis. Particular tests are frequently accepted and put into use in direct proportion to the amount of publicity which accompanies them, regardless of their proved value.

The future of the testing movement, to a large extent, is being determined now. If useless or misrepresented

measuring instruments are brought into the field, the progress of the movement will be greatly impeded. Until the areas of usefulness of valuable tests are known, these tests will be of limited benefit. Many tests have considerable use for different groups and varying types of situations. Scientific knowledge of these tests and the results of experimental studies of the tests contribute greatly to their effective use.

The reputation of the testing movement, in the last analysis, is in the hands of the users of the tests. They are the ones who select the instruments to be used and apply them to specific situations. Their responsibilities in this regard appear to be twofold: to choose the tests on the basis of scientific evidence of their usefulness and to evaluate those tests which are used by studies of their relationships with suitable criteria. Only in this way can society realize the potential contribution of objective testing to human welfare.

The measurement of special aptitudes is a phase of testing that is of unusual importance. Measurements in this field are designed to offer a basis for predicting probable success in particular fields of human endeavor. Such instruments have considerable educational value in controlling school admissions and in sectioning classes, but perhaps they have their greatest usefulness in educational and vocational counseling. However, evidence of

their predictive value for specific purposes must be available if such counsel is to be worthwhile and not valueless or even positively harmful.

This study presents some objective evidence regarding the predictive value of two particular aptitude tests.

Statement of the Problem

The problem of this study was the determination of the relationship between scores on two aptitude tests and college grades in certain related fields of subject-matter. The tests used were the Stanford Scientific Aptitude Test by Dr. D. L. Zyve and the Engineering and Physical Science Aptitude Test by Drs. Bruce V. Moore, C. J. Lapp and Charles H. Griffin. Scores on these tests were correlated separately with the grade-point averages for the total courses taken, engineering courses, mathematics courses, physical science (excluding chemistry) courses, chemistry courses and biological science courses. The number of quarters for which marks were available varied between one and six quarters, with an average slightly over two quarters.

In order to compare the predictive value of these two tests with the predictive value of general scholastic aptitude examinations, scores from the American Council on Education Psychological Examination and the Ohio State

University Psychological Test were also correlated with college grades in the various academic areas used.

Purpose of the Study

The purpose of this study was the determination of the value of the Stanford Scientific and the Engineering and Physical Science Aptitude Tests in predicting probable success in total college courses and in certain academic areas as shown by grade performances of the group studied. This contribution to the available objective evidence regarding prognostic tests should be an aid to guidance personnel in evaluating and selecting tests for use in educational and vocational counseling.

Location of the Study

This study was conducted at Oregon State College during the academic year 1946-47. This was the first college year following World War II which felt the full impact of returning veterans. The enrollment was approximately 7000 students, nearly double the pre-war number.

Subjects Employed in the Study

The subjects employed in this study were 376 male students who took the various tests at some time during the calendar year of 1946 or the first quarter of 1947. The distribution of scores on the American Council on

Education Psychological Examination indicates that these subjects were a representative sample of Oregon State College students in regard to general scholastic aptitude.

Limitations of the Study

A major limitation of this study is the lack of high reliability in regard to instructor's marks. Rogers (42, p.758-760) made a study of the reliability of college grades by correlating the various term standings of students from four consecutive classes graduating from Lafayette College. Rogers (42, p.758) concluded:

> The average reliability of term grades for the eight semesters of college is .66. . . . This is not high and leaves a great deal to be desired. Here is revealed one factor which makes for low correlation when any other tool is correlated with academic standing. This is particularly pertinent when it is remembered that the highest possible correlation between two variables is not necessarily 1.00 but is represented by a figure which may not exceed the value of the square root of the reliability of the less reliable of the two variables. In the groups used, since the square root of .66 equals .81, a test on the average may be correlated with academic standing only in the constricted scale .00 - .81.

This limitation was minimized as much as possible by using marks from Oregon State College only and by using as many term marks as were available for each student. As Traxler (54, p.58) wrote: "The reliability varies with the number of marking periods included. Marks based on one

term are obviously less reliable than marks covering the whole year's work."

Another limitation of this study was that marks were available for only one to six quarters of college work instead of for the full four years. However, grades obtained during the first year of college appear to be quite reliable indications of total college scholarship. Read (37, p.468) found rather typical correlations between each semester average and four-year average. The correlations varied from .73 to .83, with a .76 relationship between the first semester grades and the four-year average. According to Read (37, p.469), ". . . the first semester average agrees about as well with the four-year average as does the average for any other semester." Lehman found similar correspondence between individual quarter marks and four-year marks in a study at Ohio State University. According to Lehman (32, p.217), "The correlations of first-, third-, and sixth-quarter point-hour ratios each with final cumulative point-hour ratio were .66, .80, and .88, respectively." These studies appear to indicate that grades for two quarters would be fairly representative of four-year college scholarship.

CHAPTER II

HISTORICAL BACKGROUND

Studies of the predictive value of various aptitude tests used in schools have yielded information which has been very helpful in establishing the range of usefulness for each of the measures. In order to evaluate the worth of the results of the tests involved in this study, the results of some of these previous studies provide a basis for comparison.

General Scholastic Prediction

The prediction of general scholastic achievement has been facilitated by a great variety of scholastic aptitude tests. Most colleges make use of one or more of these measures in their freshman orientation program. The extensive use of these tests has given rise to a large number of studies attempting to determine the predictive values of the various tests.

One of the most widely used tests of general scholastic aptitude is the American Council on Education Psychological Examination. Most reports of relationship between scores on this test and general college achievement show coefficients of correlation in the .50's. Stalnaker (47, p.29), in a study of Purdue University freshmen in 1926, found a correlation of .57 between the American

Council on Education Psychological Examination scores and first semester grade-point average, but no index of variation was reported. A study by Kirkpatrick (28, p.38) of freshmen at Bethany College indicated a correlation with total grades of .57 for the group taking the 1938 edition and .52 for the 1937 edition. No indication of variation was reported. Crawford and Burnham (15, p.96), in 1936-37, secured a correlation of .53 for general scholastic achievement and scores on the American Council on Education Psychological Examination, with no index of variation given. Shanner and Kuder (45, p.89) found a correlation of .52 with similar data in a study of 501 University of Chicago freshmen in 1938. At the University of Minnesota, Williamson and Bordin (57, p.10), from a study of 827 Arts College freshmen in 1935, reported a correlation of .50 between American Council on Education Psychological Examination scores and two-year honor point ratio and a correlation of .46 with first-year honor point ratio. These studies indicate the average correlation for this test with total grades to be close to .53.

Another well known test for general scholastic aptitude is the Ohio State University Psychological Test. Kirkpatrick (28, p.38) at Bethany College secured a correlation of .58 between scores on this test and semester grade-point averages, but reported no measure of variation. Edgerton (19, p.18) correlated scores on this Ohio

State Test and grades at Ohio State University for 1066 freshmen in 1924 and 1073 freshmen in 1925, and secured correlations of .52 and .49 respectively. In their study made at the University of Minnesota in 1935, Williamson and Bordin (57, p.10) found correlations of .46 with two-year honor point ratio and .41 with first-year honor point ratio, using this same test. No index of variation was reported. The correlations for this test with total grades appear to center around a coefficient slightly below .50.

Other tests show varying correlations around a median of about .50. Held (23, p.13-17), working at the University of Pittsburgh, found the following correlations between grade-point average and scores on various tests: Composite Placement Test, .61; Cross English Placement Test, .53; Sones-Harry English Placement Examination, .50; and Thorndike Psychological Examination, .39. A probable error of .02 was reported for each of these correlations. Stalnaker (47, p.29) found correlations of .56 for the Iowa Chemistry Aptitude Test, .54 for the Iowa Mathematics Aptitude Test and .46 for the Iowa English Training Test. No index of variation was given for these correlations with total grades. Kirkpatrick (28, p.38) found a correlation of .59 between scores on the Pintner Test of Mental Ability and college grades, but reported no measure of variation. Jordan (27, p.356) conducted a

study of 315 freshmen at the University of Arkansas and secured a correlation with total grades of .48 for the Army Alpha Examination, with a probable error of .03. Williamson and Bordin (57, p.10) found the Minnesota College Aptitude Test to have correlations of .44 and .40, with two-year and first-year honor point ratios, respectively. No index of variation was reported. Thurstone's Tests for Primary Mental Abilities have shown the highest correlation with grades to be for the Verbal Scale. Shanner and Kuder (45, p.89) reported a correlation of .41, and Ball (3, p.19) found a .35 correlation between the Verbal Scale and average grades. Neither study reported an index of variation. Odell (36, p.28) used the Otis Self-Administering Test of Mental Ability, Higher Examination, at the University of Illinois, and found a correlation with grades of .38, with a probable error of less than one third of the coefficient.

Many other tests and other types of indicators, such as high school grades, have been used with similar results. The average high school mark is still regarded by some writers as the best single criterion for predicting performance in college (52, p.492-500). However, this measure, as reported by a large number of investigators, indicates only fair predicting efficiency. The coefficients range from .29 to .77, with an average of .54 for the sixty-seven different studies (18, p.15-16).

Williamson and Bordin (57, p.10) found a correlation of .54 for high school percentile rank and college marks in their study at the University of Minnesota, but no measure of variation was given. The great variance from the average correlations obtained for this measure, due partly to differing high school standards, makes it difficult, however, to place too much reliance upon it for predictive purposes.

Measures of general academic achievement, then, appear to have an average correlation very close to .50.

Need for Specific Scholastic Prediction

Measurements of general scholastic aptitude are useful, but they do not serve to differentiate between specific aptitudes within the large academic area provided by institutions of higher learning. An individual might succeed very differently in a social science curriculum from what he would in engineering. According to Associate Dean T. R. McConnell (57, p.iii):

> Prediction of success in college should be put on a differential basis as rapidly as possible. It is not enough to predict college achievement in general. In order to individualize students' programs so that they can make the greatest use of their particular interests, aptitudes, and previous attainments, it is essential to have some estimate of their probable achievement in different courses or curriculums.

The testing movement appears to have been going through a period of development characterized by a general-to-specific trend. The realization that tests have their usefulness in specific situations has influenced the type of tests and the methods of validation which have been developed. As Hull (25, p.19) pointed out in 1928:

> The recognition that if a test is to be of any particular value it must enable us to forecast a particular aptitude or group of aptitudes rather than measure some hypothetical or semi-metaphysical faculty, constitutes a great advance. During the period now happily drawing to a close, psychologists dominated by an essentially metaphysical notion of intelligence and consequently having no definite concrete criterion against which to test the validity of their tests, frequently moved in a circle in their scientific efforts. With the abandonment of this paralyzing idea of measuring general intelligence as the goal of testing activity, there is now appearing a vigorous and healthy concentration upon the development of tests for the greatest variety of particular concrete aptitudes.

This trend toward specific aptitude testing has given rise to conflicting ideas as to what is meant by a "specific aptitude" or "special intelligence." It is not purposed here to delve into this issue, but merely to suggest the definition intended in this study. It is well explained by Crawford and Burnham (15, p.15):

> So-called aptitudes or talents may be relatively simple or extremely complex. Few of those we shall consider for educational guidance purposes are "unitary," although often popularly referred to as if they were. Most of them represent a

> composite of several capacities. Mathematical aptitude, engineering aptitude, medical or legal aptitude, talent for art, music or teaching, are terms which serve as convenient--though inexact--labels to indicate readiness-to-learn within the respective areas designated.

Measures of specific aptitudes are needed not only for individual guidance, but for the sectioning of classes in any given subject. Such estimates of ability to learn in a special field enable school authorities to provide for individual differences by putting students in groups of similar ability where they may progress at a rate more closely approaching their optimum.

Aptitude tests for specific fields of learning also give admission advisers a more dependable basis for encouraging or discouraging entrance into a particular curriculum. Such tests may reduce considerably the percentage of students who are eliminated by the wasteful procedure of failing them out at some time during their courses of study. According to Stuit and Lapp (51, p.251):

> The prediction of scholastic success in various school subjects at the secondary and college level is one of our major personnel problems. Vocational guidance during this period consists quite largely of counseling with regard to the subjects which the student must take in order to prepare for entrance to a certain occupation. . . .
>
> A related personnel problem is that of adjusting instructional techniques to the student's particular level of ability. . . . A student who under ordinary circumstances would be doomed to academic failure might

> conceivably do a satisfactory grade of work if his level of ability were to be taken into consideration. Likewise the student with high aptitude might gain a great deal more from a course if the subject matter proved sufficiently challenging. Hence, for both educational and vocational guidance purposes, aptitude tests for specific subjects or groups of subjects should prove valuable in clinical counseling.

Need for Measuring Scientific and Engineering Aptitudes

Success in science and engineering curricula is dependent upon a number of factors such as ". . . the quality of intelligence, emotions, health, moral character, aptitude, personality traits, and a large and relatively complex group of motives" (40, p.851). Rogers and Holcomb (40, p.859) found that a knowledge of engineering motives was of considerable importance in this connection when used in conjunction with high school records and aptitude tests. It appears to be assumed that measures of special aptitude are essential to the adequate prediction of success in the field.

It has long been a concern of the engineering profession that only about forty per cent of the students who enroll as freshmen in schools of engineering survive to graduate. About half of the eliminated group fail to complete the course because of deficient scholastic aptitude for that particular curriculum (7, p.170; 24, p.1; 46, p.200-204; 48, p.76). H. A. Wagner (1, p.vi-vii),

former president of the American Association of Engineers, expressed the engineering profession's concern over this problem:

> The American Association of Engineers has long felt that there is a criminal waste of time and money--on the part of both students and schools--in the process of weeding out during the first two years of an engineering course those most obviously unfit. A large percentage of each entering class is eliminated through failures at each successive examination; only a fraction of the original group survives the finals. The psychological effect of such failures on students who should never have been admitted to the freshman class is often unfortunate, entailing loss of confidence. To a degree at least, the standard of work for the entire class, and certainly its rate of progress, must be tempered on account of these weaker students. It would obviously be ideal if this process of selection could be performed when the student applies for admission to the class, rather than, as at present, by the more cruel and expensive method of elimination. The Association feels strongly that any undertaking which retards the entrance into engineering schools and into the profession itself of those not naturally fitted for the work must strengthen the profession and make it possible for its members to demand rewards in proportion to increased efficiency. Eventually, society will feel the benefits of such better instruction and of the higher calibre of men in the profession.

Measuring scientific, as well as engineering, aptitudes may contribute to the individual's selection of educational and vocational goals in line with his general and special abilities. Wise choices in these

areas of endeavor benefit the individual in terms of success and happiness, as well as benefiting society in general in money and time saved and general discontentment avoided. Measures of specific aptitude are of considerable value, also, in locating young people with special ability who should be given opportunities to develop through appropriate educational encouragement and through scholarships awarded even in elementary schools.

Another important use of these special aptitude tests is in the selection of personnel. Selection procedures based upon subjective methods alone may often result in the rejection of capable persons. According to a study by Andrews (2, p.130), twenty-seven per cent more of a working group would have been found satisfactory if tests alone had been used in the selection.

Prediction of Success in Engineering Courses

Studies of the relation between various test scores and engineering grades at the college and university level have shown correlations as high as plus .70. The test yielding the highest correlation was the Iowa Mathematics Training Test in a study reported by Johnson (26, p.15-18). This study was made of 242 freshmen engineering students at Purdue University in 1939. Test scores were correlated with first semester engineering grades and a coefficient

of .70 was secured, with a standard error of .03. Scores on this test for another group of 227 students showed a correlation with first year engineering grades of .64, with a standard error of .04. Feder and Adler (20, p.381) found a very similar relationship with this Iowa Mathematics Training Test in a study of eighty-four first year engineering students in 1938. The correlation was .69, with a probable error of .04. Langlie (30, p.855) studied 202 engineering students at the University of Minnesota in 1926 and found a correlation of .68 between the Iowa Mathematics Training Test and engineering grades. No index of variation was given. These correlations with engineering grades using the Iowa Mathematics Training Test appear to be consistently high. The use of this test does appear to be limited, however, to students who have had previous training in mathematics upon which much of the course work in engineering is based.

The Iowa High School Content Examination, in the study made by Feder and Adler (20, p.381), showed a correlation with engineering grades of .69, with a probable error of .04. Butsch (13, p.407) used the Iowa High School Content Examination in a study of 333 engineering freshmen and secured a correlation with classroom grades of .55. He also discovered a correlation between the mathematics section of that test and grades which was slightly higher, .57. No index of variation was reported.

All of the other sections of the test showed lower correlations with engineering grades than did the mathematics section.

Johnson (26, p.15-18), in the study of 237 engineering students at Purdue University, found the Cooperative Intermediate Algebra Test to have a correlation with first semester engineering grades of .63, with a standard error of .04. In a study of 202 engineering students at the University of Minnesota, Langlie (30, p.855) found a correlation with first quarter grades of .60 for the Iowa Mathematics Aptitude Test and .58 for the Iowa Chemistry Aptitude Test. No measures of variation were reported. Feder and Adler (20, p.381) found the Iowa English Placement Test to have a correlation of .60, with a probable error of .05, with engineering grades. At the University of Maine, Brush (11, p.307) made a study of twenty-one tests and found only two of the group to have correlations with engineering marks which were above .50. The Columbia Research Bureau Physics Test gave a coefficient of .59, with a probable error of .04, and the Columbia Research Bureau Algebra Test gave a .53 correlation, with a probable error of .04.

The American Council on Education Psychological Examination has been found to have correlations with engineering grades varying from .56 down to .34. Johnson (26, p.15-18) reported the .56 coefficient between this test

and engineering grades, with a standard error of .04. Holcomb (24, p.32), in his study at Oregon State College, secured a correlation between this test and engineering grades of .55, with a probable error of .06. At Marquette University, Butsch (13, p.405) discovered a correlation between scores on the American Council on Education Psychological Examination and engineering grades of .52, but no index of variation was given. Waits (56, p.268) reported from a study of the grades of 212 engineering students that the correlation with this test was .47. Laycock and Hutcheon (31, p.280) found the correlation between this test and first year engineering marks to be as low as .34, but no measure of variation was reported. The various studies appear to indicate a median coefficient of about .52 for the correlation between the American Council on Education Psychological Examination and engineering grades.

Johnson (26, p.15-18), in his study at Purdue University, found a correlation with engineering grades for the Purdue Placement Test in English of .54, with a probable error of .04. He also found the Verbal Scale of Thurstone's Tests for Primary Mental Abilities to have a correlation with engineering grades of .52, with a probable error of .05. However, two other studies have indicated lower correlations for this Verbal Scale of

Thurstone's Test and engineering grades. Bernreuter and Goodman (6, p.59) reported a correlation of .33 and Goodman (22, p.56), in another study, found a relationship of .34 between scores on the Verbal Scale and engineering grades. No measures of variation were given. The other scales of the Thurstone Test showed correlations with engineering marks varying from .04 to .38.

At the University of Arkansas, Jordan (27, p.357) secured a correlation with engineering grades, using the Army Alpha Examination, of .51 with a probable error of .06. The Ohio State University Psychological Test, as reported by Edgerton (19, p.18), gave a correlation with grades of .46 in a study of 372 freshmen in an engineering curriculum, but no index of variation was reported.

Butsch (13, p.405) found a correlation between high school rank and engineering grades of .55, with no measure of variation given, in a study of 333 freshman engineering students at Marquette University.

These studies indicate that there is one test, the Iowa Mathematics Training Test, which consistently shows a correlation higher than .60. Others have constant relationships in the .50's and even a general scholastic aptitude test such as the American Council on Education Psychological Examination shows an average correlation of about .52 with engineering grades.

Prediction of Success in Mathematics Courses

As one of the most essential tool subjects of engineering, mathematics is very closely related to engineering itself. Prediction of success in mathematics does not appear to be considerably different from the prediction of success in engineering courses.

The same test which gave the highest correlation for engineering, the Iowa Mathematics Training Test, also had the highest relationship with mathematics. Remmers (38, p.42) made a study of 620 students at Purdue University in 1928 and found the scores on the Iowa Mathematics Training Test and mathematics grades to correlate to the extent of .66, but no index of variation was given. Stoddard (49, p.78) reported a correlation for the same test of .52 from a study of 100 University of Iowa students. He also found that the Iowa Mathematics Aptitude Test gave a correlation with mathematics grades of .41. No measures of variation were indicated. Langlie (30, p.851) computed the correlation between test scores and mathematics grades for 183 students at the University of Minnesota and found coefficients of .49 for the Training Test and .41 for the Aptitude Test. No index of variation was reported.

Another widely used test for mathematical prediction is the mathematical section of the College Entrance

Examination Board Test. Crawford and Burnham (14, p.301) reported correlations for this section of the test and mathematics grades between .42 and .62, using numbers of subjects varying from 133 to 329. No measures of variation were given. Landry (29, p.257) conducted a study of 204 college freshmen and found the mathematical section of this test to give a correlation of .49, with a probable error of .04. He also found a correlation between the total score of the College Entrance Examination Board Test and mathematics grades of .43 with a probable error of .04.

Landry (29, p.257) also reported a correlation for the Cooperative Test Service Mathematics Test and college mathematics marks of .48, with a probable error of .04. Crawford and Burnham (14, p.301) reported correlations with mathematics grades varying from .39 to .66 for the Quantitative Reasoning Test (Test IV of the Yale Battery). Numbers of subjects used varied from 133 to 329, but no index of variation was reported.

The American Council on Education Psychological Examination's quantitative section (Q-score) has been reported by Seder (44, p.99) to correlate to the extent of .51, with a probable error of .03, with high school mathematics grades. Seder (44, p.100) also found a correlation between the total score of the American Council on Education Psychological Examination and grades in high

school mathematics courses of .51, but reported no measure of variation. Williamson and Bordin (57, p.23) found scores on this test to have a correlation of .41 with college mathematics grades, but indicated no index of variation.

Held's (23, p.22) report from the University of Michigan showed the Composite Placement Examination to have a correlation of .49, with a probable error of .02, and the Columbia Research Bureau Algebra Test to have a correlation with college mathematics grades of .48, with a probable error of .02. Odell (36, p.28) using the Otis Self-Administering Test of Mental Ability, Higher Examination, discovered a relationship of .46 with college freshman arithmetic grades, with a probable error of less than one third of the coefficient. Ball (3, p.19) computed correlations for the parts of the Thurstone Tests for Primary Mental Abilities and discovered the Number Scale to have a relationship with first semester college mathematics grades of .41 and the Deductive Reasoning Scale, .35, with a probable error of .10 for both correlations. The correlations for the other scales were all lower. Bernreuter and Goodman (6, p.59) ran similar correlations with college mathematics marks and found the Deductive Reasoning Scale to have a .44 coefficient; the Inductive Reasoning Scale, .29; and the Number Scale, .27, with all the other scales

lower. One hundred and seventy students were used in the study, but no measures of variation were given. Root (43, p.79) made a study of 569 freshmen at the University of Pittsburgh and discovered the correlation between the Thorndike Intelligence Examination for High School Graduates and mathematics grades to be .39, with a probable error of .06. The Army Alpha Examination was shown to have a correlation with college mathematics grades of .38, with a probable error of .03 by Stone (50, p.299) and of .21, with a probable error of .04, by Jordan (27, p.356).

Williamson and Bordin (57, p.23) reported a correlation between high school percentile rank and college mathematics marks of .49, but no index of variation was indicated.

Prediction of Success in Physical Science (Excluding Chemistry) Courses

The prediction of success in the physical sciences (excluding chemistry) has centered mostly around physics itself. Studies in the field have reported correlations up to .78, but that high a relationship has been so rarely found that it does not appear to be adequately substantiated as yet.

Stuit and Lapp (51, p.253) conducted a study of 107 students at the University of Iowa, using the Iowa Mathematics Aptitude Test and the Iowa Physics Aptitude Test in correlation with physics achievement. They found correlations of .78 and .66 for the respective tests when each one was correlated with physics grades. In another phase of their study, they found a correlation of .50 between scores on the Iowa Physics Aptitude Test and scores on the Cooperative Physics Achievement Test. No measures of variation were included in the report of the study. Bear (4, p.382) also used the Iowa Physics Aptitude Test in a study of thirty-eight freshmen in a college physics class and found a correlation of .50, with a probable error of .08, for the first semester physics grades and a correlation of .25, with a probable error of .10, for first year physics grades. Bear concluded (4, p.384): "In light of the above it would seem inadvisable to assign more than slight value to the test for predicting capacity for work in physics." It does seem to appear that the most probable average correlation for the Iowa Physics Aptitude Test and physics achievement is around .50.

Marshall (34, p.707-708) made a study in 1939 of 18 senior students at Franklin and Marshall College, using the Stanford Scientific Aptitude Test and physics grades. His obtained correlation for scores on this

test and physics grades was .77, with a probable error of .07. This figure may not be very reliable in view of the fact that his students "were selected so as to include both good and poor students." (34, p.707). This procedure might tend to give spuriously high correlations. The small number of subjects used increased considerably the chance of sampling error, also. Marshall (33, p.433-434) reported another study of the Stanford Scientific Aptitude Test and college science grades in 1942 with astonishingly different results. In this study, with a group of forty-six students, he found the test scores to correlate with physics grades to the extent of .42, with a probable error of .08. These conflicting reports on the Stanford Scientific Aptitude Test's predictive value for success in physical science courses indicates that further studies are needed to determine the true relationship.

Crawford and Burnham (14, p.301), in their study at Yale, found the mathematical section of the College Entrance Examination Board Test to have correlations with college physics grades ranging from .31 to .59 and the Quantitative Reasoning Test (Test IV of the Yale Battery) to have correlations varying from .22 to .49. Groups of subjects numbering from 161 to 354 were used in these studies, but no measures of variation were reported.

Moore (35, p.633), in connection with defense training courses established during World War II, found correlations for two tests as they were related to scores on the Cooperative Mechanics Test, a physics achievement test. He found the Bennett Test of Mechanical Comprehension to show a correlation with scores on the physics achievement test of .52 and discovered the Otis Self-Administering Test of Mental Ability, Higher Examination, to correlate to the extent of .50 with the same criterion. Two hundred ninety-two students were used in the study, but no index of variation was given. Stuit and Lapp (51, p.252) found scores on the Mann Engineering Drawing Aptitude Test to have a correlation of .51 with college physics grades. No measure of variation was reported. Rogers (41, p.334) found an average correlation for the Thorndike Intelligence Test and college physics grades of .49, with probable errors ranging from .03 to .07. Root (43, p.79) secured a comparable correlation of .50, with a probable error of .04, for the same test and physics grades in a study at the University of Pittsburgh. Shanner and Kuder (45, p.90), in a study of freshmen taking an introductory physical science course at the University of Chicago, found the following correlations between grades in the course and scores on tests: the Deductive Reasoning Scale of Thurstone's Tests for Primary Mental Abilities, .48; the American

Council on Education Psychological Examination, .48; and the College Entrance Examination Board Test, .47. No measures of variation were reported. Stone (50, p.299) reported a .44 correlation, with a probable error of .05, between Army Alpha Examination scores and first semester college physics grades.

Studies of the American Council on Education Psychological Examination and physical science grades have shown differing relationships. Crawford and Burnham (15, p.96) reported a correlation of .40 for the total score on this test and grades in a physical science introductory course at the college level, but no index of variation was given. Seder (44, p.99-100) found correlations with high school physics grades of .29 for the total score on the American Council on Education Psychological Examination, .23 for the quantitative part score and .27 for the language part score, with a probable error for each correlation of .07. Brewer (9, p.20) obtained correlations with college physical science grades for this test's total score of .26, for the Q-score of .18 and for the L-score of .22. No index of variation was reported.

Held (23, p.22) secured a correlation between the Columbia Research Bureau Physics Test and college physics grades of .32, with a probable error of .07. Ball's (3, p.19) study of the Thurstone Tests for Primary Mental

Abilities shows the Deductive Reasoning Scale to have a correlation with grades in physical science courses of .31, with a standard error of .06. This is considerably lower than the .48 reported for the same types of data in the study by Shanner and Kuder (45, p.90). All the other scales in this test evidenced a lower relationship with physical science grades than did the Deductive Reasoning Scale.

Measuring devices in the field of physical science appear to give consistent relationships with physical science grades which are little better than the predictive values obtained from the measures designed for the prediction of general scholastic achievement. The Iowa Mathematics Aptitude Test, as an exception, has shown a fairly high predictive value for physics grades, having a correlation of .78 in one study. However, more studies of this type are needed to confirm or deny this high correspondence.

Prediction of Success in Chemistry Courses

Studies of prediction in the field of chemistry find the Iowa Chemistry Aptitude Test and the Iowa Chemistry Training Test giving the highest consistent relationships with classroom grades in this subject. These tests show correlations ranging from .57 down to .34.

The Iowa Chemistry Aptitude Test is reported by Reusser, Brinegar and Frank (39, p.199) to have a correlation with college chemistry grades of .57, with a probable error of .05. Langlie (30, p.851) found the test to have the same correlation in his study at the University of Minnesota. Remmers (38, p.42) reported a very similar correlation at Purdue University, that is, .55, from a study of 244 students, but no index of variation was given. Cornog and Stoddard (16, p.704) found a somewhat lower average relationship for this test and chemistry grades of .44, with an average probable error of .06, in a study involving 648 students from five universities. Stoddard (49, p.75), in a study of 100 students at the University of Iowa, secured a .40 correlation between the Iowa Chemistry Aptitude Test and chemistry grades, but reported no measure of variation.

The other test in the Iowa chemistry series, the Iowa Chemistry Training Test, has been reported by Reusser, Brinegar and Frank (39, p.199) to show a correlation with chemistry grades of .57, with a probable error of .05. The same correlation was found by Cornog and Stoddard (16, p.704) in a similar study, but Langlie (30, p.851) found the test to have a correlation of only .43 in a study of 168 students who were members of one chemistry class at the University of Minnesota. No measures of variation were reported. Stoddard (49, p.75)

also found a low correlation, that of .34, in his study of the Iowa Chemistry Training Test with sixty-nine chemistry students at the University of Iowa. On the whole, however, it appears that the Iowa Chemistry Aptitude and Chemistry Training Tests correlate with college chemistry grades about .55.

The one study (55, p.171) of the Columbia Research Bureau Chemistry Test found it to have correlation with chemistry grades of .63, with a probable error of .06, but as only fifty subjects were employed, any true relationship between these types of data has not been sufficiently established at present to be accepted.

Seder (44, p.100) reported correlations with high school chemistry grades of .55, .55 and .38, respectively, for the American Council on Education Psychological Examination total score, L-score and Q-score. Held (23, p.22) found the Powers Chemistry Placement Test to correlate with college chemistry grades to the extent of .54, with a probable error of .02, using 362 subjects. Remmers (38, p.42) reported the Iowa Mathematics Training Test to have a correlation of .52 with college chemistry grades in a study of 195 students at Purdue University. Rogers (41, p.334) found an average correlation of .45, with probable errors varying from .03 to .07, between the Thorndike Intelligence Test and grades in college chemistry courses. For the same types of data, Root (43, p.79)

found a similar correlation of .43, with a probable error of .03. Dickter (17, p.44) reported the mathematical section of the College Entrance Examination Board Test to correlate to the extent of .42, with a probable error of .01, with college chemistry marks.

Bernreuter and Goodman (6, p.59), in their study of the several parts of Thurstone's Tests for Primary Mental Abilities and chemistry grades, found the highest correlation for the Deductive Reasoning Scale, that of .41. Ball (3, p.4) also found the Deductive Scale to be the highest among the Thurstone Tests and to have the same correlation of .41 with chemistry grades. Reusser, Brinegar and Frank (39, p.199) secured a correlation of .42, with a probable error of .05, between the Ohio State University Psychological Test and grades in college chemistry courses.

Marshall's (33, p.433-434) second study showed the Stanford Scientific Aptitude Test to correlate with grades in college chemistry courses to the extent of .36, with a probable error of .08, using forty-seven subjects. His previous study (34, p.708) gave a correlation of .80, with a probable error of .06, but special selection and a low number of subjects suggest that this figure may not have been truly representative.

Stone (50, p.299) found a correlation of .31, with a probable error of .04, between the Army Alpha Examination and chemistry grades. Odell (36, p.28) found a correlation of .30 between the Otis Self-Administering Test of Mental Ability, Higher Examination, and marks in college chemistry classes.

Success in chemistry courses, it seems, correlates on an average approximately .55 with some of the existing tests, including the Iowa Chemistry Aptitude Test, the Iowa Chemistry Training Test and the American Council on Education Psychological Examination.

Prediction of Success in Biological Science Courses

Studies in this area use criteria such as grades in biological science, introductory courses, zoology courses and botany courses. Seder (44, p.100) reported correlations between high school biology grades and the American Council on Education Psychological Examination as follows: total score, .56; L-score, .60; and Q-score, .30. Williamson and Bordin (57, p.22) found a relationship of .49 between the total scores on this test and college biology honor points, and Shanner and Kuder (45, p.90) reported a .48 correlation. Crawford and Burnham (15, p.96) obtained a similar correlation, .47,

using grades from an introductory biological science course. No index of variation was reported.

Held (23, p.22) used the Ruch-Cossman Biology Placement Test and found correlations of .56, with a probable error of .06, with botany grades and .49, with a probable error of .05, with zoology marks. Wagner (55, p.172) secured a correlation of .55 with zoology grades by using the science sub-test of the Iowa High School Content Examination. However, this science sub-test correlated only .34 with botany marks. No measures of variation were given. The Thorndike Intelligence Examination has shown correlations with college biology grades of .52, with a probable error of .05 (43, p.79), and of .43, an average of coefficients, with probable errors varying between .03 and .07 (41, p.334).

Marshall (33, p.433-434) found the Stanford Scientific Aptitude Test to correlate with biology grades to the extent of .52, with a probable error of .07, in his later study of forty-six college students. In his earlier study of eighteen picked seniors (34, p.708), Marshall obtained a correlation of .71, with a probable error of .09, which seems artificially high.

Shanner and Kuder (45, p.90), in their study at the University of Chicago, discovered a .48 correlation between the College Entrance Examination Board Test and an introductory course in biological science, but reported no

index of variation. The Ohio State University Psychological Test has been shown to correlate to the extent of .46 with science honor points obtained in biological science courses (57, p.22). The Deductive Reasoning Scale of Thurstone's Tests for Primary Mental Abilities showed a correlation of .42 with biology grades (45, p.90) and a coefficient of .23 with grades in botany courses (3, p.19). The Otis Self-Administering Test of Mental Ability, Higher Examination, (36, p.28) was found to correlate to the extent of .42 with botany grades and of .20 with biology grades, but no measures of variation were given. Stone (50, p.299) reported a correlation of .22, with a probable error of .045, between the Army Alpha Examination and grades in biology.

It appears from these studies that the highest consistent relationship between biology grades and the most appropriate tests is represented by a coefficient of correlation of .50. This correlation with grades in courses in biological science is practically identical with those found between general scholastic aptitude tests and general academic achievement.

This review of studies in the prediction of success in the various scholastic subjects presents a background of information which facilitates the evaluation of results obtained from similar comparisons of the two tests

involved in this study, the Stanford Scientific Aptitude Test and the Engineering and Physical Science Aptitude Test. A review of the studies of these tests to determine what has been learned as to their specific predictive value follows.

Prediction of Scholastic Success by the Stanford Scientific Aptitude Test

The author of the Stanford Scientific Aptitude Test, Dr. D. L. Zyve (58, p.536), reported a study which was conducted in connection with the validation of the test. It was done by having judges (faculty members who were best acquainted with the experimental group of students) rate the students as to scientific aptitude. These ratings were then correlated with scores from this test with the following results: ten physics students, .95, with a probable error of .07; nineteen electrical engineering students, .89, with a probable error of .03; and twenty-one chemistry students, .77, with a probable error of .06. Zyve (58, p.536) also correlated his test scores with total grade-point averages for two separate groups of students. One was a scientific group and the other was a non-scientific group, as determined by the type of courses they were taking. He found a correlation of .50, with a probable error of .07, for the scientific group

and a coefficient of .02, with a probable error of .09, for the non-scientific group.

Marshall's (34, p.707-708) 1939 study of 18 seniors, who were definitely selected so as to include both good and poor students in science courses, showed correlations for physics grades of .77, with a probable error of .07; chemistry grades, .80, with a probable error of .06; biology grades, .71, with a probable error of .09; and total science grades, .78, with a probable error of .065. The reliability of these coefficients, however, may be subject to some question because of the special selection and the small number of cases used. Selecting cases from the extremes of performance tends to have the effect of raising any correlation which is obtained. The small number of cases increases the chance factor in the relationship secured.

Marshall must have realized the necessity for further study of this test, for he followed it with another in 1942 (33, p.433-434). In this study, forty-three to forty-seven subjects were used and, apparently, they were selected at random by the inclusion of entire groups. The sizes of these groups offered a better basis for establishing relationships than did the former group. This study showed strikingly different correlations from those obtained earlier, to wit: physics grades, .42, with a probable error of .08; chemistry grades, .36, with a

probable error of .085; biology grades, .52, with a probable error of .07; and freshman and sophomore total science grades, .40, with a probable error of .09. Marshall also reported a reliability coefficient of .98 for the Stanford Scientific Aptitude Test, based on the scores of twenty-five students who took the test at the end of their sophomore year and again during their senior year (33, p.433-434). However, Crawford (12, p.454), in The Nineteen Forty Mental Measurements Yearbook, reported a reliability coefficient of .60 for this test, by the method either of split-half, or of paired successive sub-test scores.

In 1940, Benton and Perry (5, p.311) made a study of the Stanford Scientific Aptitude Test involving forty-three students, and compared the correlations obtained from it with those from the American Council on Education Psychological Examination for three selected areas of scholastic achievement. They found that for total grades the Stanford Scientific Aptitude Test showed a correlation of .37, with a probable error of .09, and the American Council on Education Psychological Examination showed a coefficient of .31, with a probable error of .09. For scientific grades (including biology, chemistry, physics, drafting, engineering geology, and mathematics), the correlation from the Stanford Test was .37, with a

probable error of .09, and from the other test it was .27, with a probable error of .10. For the non-scientific grades, the relationship was .30, with a probable error of .09, for this Stanford Test and .41, with a probable error of .09, for the American Council on Education Psychological Examination.

Another study on the Stanford Scientific Aptitude Test was reported by Crawford (12, p.454-455) in which the test was administered to a representative group of 143 Yale University freshmen. A correlation of .30 was found between test scores and year-grades in science or pre-engineering courses, but no index of variation was given.

It is apparent that the studies on this test are not extensive enough to enable adequate evaluation to be made of its values for predicting success in specific curricula.

Prediction of Scholastic Success by the Engineering and Physical Science Aptitude Test

The Engineering and Physical Science Aptitude Test was published in 1943 and no studies on it have apparently become available as yet, with the exception of the one reported in the manual for the test (8, p.5). This study, conducted in 1942, was used to validate the test. Correlations were computed for 188 high school graduates

taking summer courses in introductory engineering subjects. The correlation for the total grades from the engineering courses was .73; physics grades, .72; chemistry grades, .66; mathematics grades, .59; grades in manufacturing processes, .38; and drafting grades, .35. No measures of variation were shown. It is evident that other studies on the predictive value of this test are needed.

This review of studies in certain fields of scholastic prediction indicates that much remains to be done, if prognosis of success in special academic areas is to be effective. The whole field still appears to be in an exploratory stage.

CHAPTER III

THE STUDY

The specific purpose of this study was the determination of relationship between certain tests and success in various academic areas at the college level. This relationship was measured through correlations, using the product-moment method in the calculation of the coefficients.

Tests Used in the Study

The two tests of special concern in this study were designed to measure aptitude in science or engineering. One of these was the Stanford Scientific Aptitude Test, by Dr. D. L. Zyve. It was copyrighted in 1929, 1930, and is intended for use with high school and college students. It is published by the Stanford University Press, Stanford University, California. This test attempts to measure scientific aptitude by means of eleven sub-tests (21, p.177) upon the following topics: (1) experimental bent, (2) clarity of definition, (3) suspended versus snap judgment, (4) reasoning, (5) inconsistencies, (6) fallacies, (7) induction, deduction and generalization, (8) caution and thoroughness, (9) discrimination of values in selecting and arranging

experimental data, (10) accuracy of interpretation, and (11) accuracy of observation. It is a power examination of the group, pencil-and-paper, language and performance types of tests and takes between one and two hours to complete. It has no set time limits.

The other test was the Engineering and Physical Science Aptitude Test compiled under the direction of Drs. Bruce V. Moore, C. J. Lapp and Charles H. Griffin of The Pennsylvania State College (8, p.1-8). It was copyrighted in 1943 and is intended for use at the college level. It is published by The Psychological Corporation, 522 Fifth Avenue, New York 18, New York. This test attempts to measure aptitude for engineering and for physical science by means of six individually timed parts: (1) mathematics, (2) formulation, (3) physical science comprehension, (4) arithmetic reasoning, (5) verbal comprehension, and (6) mechanical comprehension. Time limits for the individual parts vary from ten to fifteen minutes. This pencil and paper test takes an over-all time of about an hour and fifteen minutes to complete.

The American Council on Education Psychological Examination and the Ohio State University Psychological Test were also used in this study for comparison purposes. The American Council on Education Psychological

Examination was used in three ways: (1) total score, (2) quantitative or Q-score, and (3) language or L-score.

This study has, thus, made use of six test variables: (1) the Stanford Scientific Aptitude Test, (2) the Engineering and Physical Science Aptitude Test, (3) The American Council on Education Psychological Examination total score, (4) the American Council on Education Psychological Examination Q-score, (5) the American Council on Education Psychological Examination L-score, and (6) the Ohio State University Psychological Test.

Grades Used in the Study

The grades used in the study were all from Oregon State College courses. Grades were given honor-point values in accordance with the system employed at the College: A equals four; B, three; C, two; D, one; and F, zero, for each hour of credit. The total number of honor points involved was finally divided by the number of hours to find the grade point average related to the problem.

Grades were available for the first two quarters of college work in the case of sixty-two per cent of the 376 subjects used in the study, as shown in Table I. Grades available for the remaining thirty-eight per cent were for numbers of quarters varying from one to six.

Table I

Distribution of Subjects by the Number of Quarters for Which Grades Were Available

Quarters	Number	Per Cent of Total
One Quarter	52	14
Two Quarters	232	62
Three Quarters	39	10
Four Quarters	30	8
Five Quarters	20	5
Six Quarters	3	1
Total	376	100

Median Number of Quarters - 2

Mean Number of Quarters - 2.3

For the most part, the grades represented marks obtained during the 1946-1947 academic year.

Six categories of grades were used in this study: (1) total grades, (2) engineering, (3) mathematics, (4) physical science (excluding chemistry), (5) chemistry, and (6) biological science. Each subject's grades in any of the above areas in which he had taken courses were extracted and the grade-point average computed.

Total grade-point averages were determined by averaging all grades available at Oregon State College for each individual used. This average represented courses in all areas rather than merely a total of the five selected academic areas treated in the study.

Physical science (excluding chemistry) grade-point averages were found by extracting grades in all physics, geology, astronomy and physical science survey courses.

Chemistry grade-point averages were based upon all chemistry courses, except that courses in chemical engineering were excluded as they seemed to be more properly located in the engineering area.

Biological science grade-point averages were computed from grades in courses in the fields of bacteriology, botany, entomology, and zoology. Biological science survey courses and courses in bioecology were also included.

Engineering grade-point averages were determined by averaging the grades available for chemical, civil, electrical, mechanical, mining and general engineering courses.

Mathematics grade-point averages were ascertained by using all grades available in the mathematics field.

Subjects Employed in the Study

This study involved 376 Oregon State College male students who took at least one of the two aptitude tests on which this study is based and at least one of the two general scholastic aptitude tests employed. The subjects took these tests at some time during the calendar year 1946 or the first quarter of 1947.

The students used in this study were distributed among eight separate schools of Oregon State College, as shown in Table II. Over half of the subjects were enrolled in the Schools of Engineering or Lower Division. The remainder were in the schools of Business and Industry, Agriculture, Science, Forestry, Pharmacy and Education.

The subjects of this study represented students who sought the aid of the counseling service at the College. On the American Council on Education Psychological Examination, they appeared to be representative of average college freshmen in regard to general scholastic aptitude, as shown in Table III. The distribution of scores for these subjects on this examination indicates this group to be slightly higher than the usual freshman group at Oregon State College, with the median score of the studied group six points higher. The distribution of the scores on the Ohio State University Psychological Test also indicates this group to be slightly superior in general

Table II

Distribution of Subjects Employed in the Study by Schools

School	Number	Per Cent of Total
Agriculture	36	10
Business and Industry	59	16
Education	4	1
Engineering	137	36
Forestry	16	4
Lower Division	86	23
Pharmacy	8	2
Science	30	8
Total	376	100

scholastic aptitude to the average college freshman group, with the median score of the studied group three points higher, as shown in Table IV.

The distribution of subjects by the established deciles of these two general scholastic aptitude tests, while not showing an exact ten per cent in each decile, confirms the opinion that the group is quite representative of average college freshmen in regard to academic aptitude. Throughout the last eighteen years, the Oregon State College norms and the national norms for the

Table III

Distribution of Subjects Employed in the Study by Deciles of the American Council on Education Psychological Examination*

Decile	Number	Per Cent of Total
10th	58	16
9th	41	11
8th	42	12
7th	37	10
6th	42	12
5th	36	10
4th	34	9
3rd	24	7
2nd	31	8
1st	17	5
Total	362	100

Median of Scores for the Subjects in This Study - 104

Median of Scores for All Oregon State Freshmen, 1946 - 98

*Deciles are from the Oregon State College Freshman norms for the fall of 1946.

Table IV

Distribution of Subjects Employed in the Study by Deciles of the Ohio State University Psychological Test*

Decile	Number	Per Cent of Total
10th	17	5
9th	34	10
8th	43	12
7th	50	14
6th	45	13
5th	36	10
4th	47	13
3rd	41	11
2nd	30	8
1st	13	4
Total	356	100

Median of Scores for the Subjects in This Study - 78

Median of Scores for Ohio College Freshmen - 75

*Deciles are based on 3889 Ohio College freshmen tested in the autumn of 1940. (53, p.4)

American Council on Education Psychological Examination have had approximately the same means and distributions, except that the range of scores at Oregon State College has been slightly contracted at both extremes.

Procedure

The procedure used in this study was that of correlating individual scores on each of the various tests with grade-point averages in each of the six academic areas used. The coefficients of correlation were determined by the product-moment method. The probable variability of the obtained correlations was computed in terms of the probable error.

Results of the Study

The tests used in this study showed correlations with total college grades varying from .51 to .39, with probable errors from .03 to .04, as shown in Table V. The Engineering and Physical Science Aptitude Test appeared to predict success in general college work as accurately as did the total score on the American Council on Education Psychological Examination, both showing correlations of .51 with total grade-point average. The Stanford Scientific Aptitude Test showed least relationship with general college achievement, having a correlation of .39 with total grade-point average. The correlation with total grades of .51,

Table V

Correlations Between Total Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.39	.04	190
Engineering and Physical Aptitude Test	.51	.03	308
ACE Psychological Examination Total Score	.51	.03	362
ACE Psychological Examination Q-Score	.44	.03	362
ACE Psychological Examination L-Score	.45	.03	362
Ohio State University Psychological Test	.45	.03	356

referred to above, which was found for both the Engineering and Physical Science Aptitude Test and the American Council on Education Psychological Examination total score, is very similar to that obtained in other studies of general scholastic prediction (15, 19, 23, 27, 28, 45, 47, 57).

The correlations between the test scores and engineering grade-point averages varied from .40 to .23, with probable errors between .04 and .06, as shown in Table VI. The American Council on Education Psychological Examination

Table VI

Correlations Between Engineering Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.37	.06	82
Engineering and Physical Science Aptitude Test	.39	.04	211
ACE Psychological Examination Total Score	.39	.04	215
ACE Psychological Examination Q-Score	.40	.04	215
ACE Psychological Examination L-Score	.29	.04	215
Ohio State University Psychological Test	.23	.04	211

Q-scores and total scores, the Engineering and Physical Science Aptitude Test scores and the Stanford Scientific Aptitude Test scores appear to be about equal in their predictive value for engineering success, having correlations varying from .40 to .37. The Ohio State University Psychological Test scores were least valuable for this purpose, showing a correlation of only .23. These correlations with engineering grades were considerably lower than those reported for other measures such as the Iowa Mathematics Training Test, the Iowa High School Content

Table VII

Correlations Between Mathematics Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.33	.05	160
Engineering and Physical Science Aptitude Test	.35	.03	293
ACE Psychological Examination Total Score	.41	.03	325
ACE Psychological Examination Q-Score	.43	.03	325
ACE Psychological Examination L-Score	.31	.03	325
Ohio State University Psychological Test	.26	.04	321

Examination, the Cooperative Intermediate Algebra Test and others (13, 20, 26, 30).

The various tests used in this study and the mathematics grade-point averages showed correlations of .43 to .26, with probable errors of .03 to .05, as shown in Table VII. The American Council on Education Psychological Examination Q-scores and total scores gave the highest correlations of .43 and .41, respectively. The Ohio State University Psychological Test showed the lowest correlation with mathematics grades, having a coefficient of .26.

The correlations of these tests and mathematics grade-point averages do not compare favorably with the higher correlations obtained with other measures in the field. The Iowa Mathematics Training Test and the mathematical section of the College Entrance Examination Board Test and other instruments have shown higher coefficients of correlation (14, 29, 30, 38, 49).

Prediction of success in physical science (excluding chemistry) courses was achieved most accurately in this study by the Engineering and Physical Science Aptitude Test, which showed a correlation of .43 with physical science grade-point average, as shown in Table VIII. The American Council on Education Psychological Examination total score predicted nearly as well, however, as it had a correlation of .38 with the same criterion. The Stanford Scientific Aptitude Test appeared to predict success least accurately, showing a correlation of only .16 with physical science (excluding chemistry) grade-point average. The highest correlation with physical science (excluding chemistry) grades obtained in this study does not appear to be as high as has been found for other tests such as the Iowa Mathematics Aptitude Test and the Iowa Physics Aptitude Test (4, 51).

Correlations between the several tests used and chemistry grades varied from .57 to .42, with probable

Table VIII

Correlations Between Physical Science (Excluding Chemistry) Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.16	.07	78
Engineering and Physical Science Aptitude Test	.43	.04	173
ACE Psychological Examination Total Score	.38	.04	177
ACE Psychological Examination Q-Score	.31	.05	177
ACE Psychological Examination L-Score	.35	.04	177
Ohio State University Psychological Test	.36	.04	178

errors from .05 to .06, as may be seen in Table IX. The Stanford Scientific Aptitude Test, the Engineering and Physical Science Aptitude Test, and the American Council on Education Psychological Examination total score had the highest correlations with chemistry grade-point average, showing .57, .56 and .54, respectively. The lowest correlation, .42, was found for the Ohio State University Psychological Test. The correlations found for these three tests showing the highest relationships with chemistry

Table IX

Correlations Between Chemistry Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.57	.05	69
Engineering and Physical Science Aptitude Test	.56	.05	71
ACE Psychological Examination Total Score	.54	.05	99
ACE Psychological Examination Q-Score	.49	.05	99
ACE Psychological Examination L-Score	.45	.05	99
Ohio State University Psychological Test	.42	.06	99

grade-point averages appear to be at least as high as those reported for other widely used tests in the field. The Iowa Chemistry Aptitude Test and the Iowa Chemistry Training Test show coefficients of correlation no higher than .57 (16, 38, 39).

The scores on the different tests used in this study and grades in biological science subjects had correlations ranging from .64 to .32, with probable errors from .06 to .07, as shown in Table X. The highest correlation, .64, was found for the Engineering and Physical Science

Table X

Correlations Between Biological Science Grade-Point Averages and Scores on Selected Tests

Test	r	P.E.	N
Stanford Scientific Aptitude Test	.37	.07	61
Engineering and Physical Science Aptitude Test	.64	.06	40
ACE Psychological Examination Total Score	.43	.06	79
ACE Psychological Examination Q-Score	.32	.07	79
ACE Psychological Examination L-Score	.43	.06	79
Ohio State University Psychological Test	.41	.06	76

Aptitude Test. The correlations found for the other tests and biological science grades were approximately twenty points lower. The lowest relationship with biological science grade-point averages was secured for the American Council on Education Psychological Examination Q-scores. The correlation of .64 obtained for the Engineering and Physical Science Aptitude Test scores and biological science grades is higher than has been found in other similar studies of tests in this field (15, 23, 36, 41, 43, 44, 45, 55, 57). However, in view of the fact that

Table XI

Correlations Between the Stanford Scientific Aptitude Test Scores and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.39	.04	190
Engineering	.37	.06	82
Mathematics	.33	.05	160
Physical Science (Excluding Chemistry)	.16	.07	78
Chemistry	.57	.05	69
Biological Science	.37	.07	61

this correlation represents the lowest number of cases (forty) used in this study, its validity may be subject to some question.

In re-presenting the material just shown in this paper, but with groupings by tests used instead of by subject areas, the Stanford Scientific Aptitude Test showed correlations between .57 and .16, with probable errors from .04 to .07, as may be seen in Table XI. This test correlated most highly with chemistry grade-point averages, showing a coefficient of .57. The lowest correlation for the test, that of .16, was with physical

science (excluding chemistry) grade-point averages. On the whole, the test's correlations with science grade-points were very similar to the .39 correlation of the test with total grades. It does not appear to differentiate between scientific aptitude and general scholastic aptitude. The results of this study of the Stanford Scientific Aptitude Test confirmed most of the other studies on the test which showed correlations centering around .30 to .40 with success in college science courses (5, 12, 33).

The distribution of scores for the group of 190 Oregon State College students who took the Stanford Scientific Aptitude Test showed that thirty-seven per cent of them fell into the lowest decile according to norms based on the standardization group, as may be seen in Table XII. It also indicated that eighty-three per cent of the local scores fell at or below the fiftieth percentile of those norms. The median score for the standardization group was twenty-seven points higher than the median score for the group involved in this study. In view of the fact that this local group was found to be slightly superior in general scholastic aptitude, a more normal distribution on the Stanford Test might have been expected. It is evident that the group on which the test was standardized made considerably

Table XII

Distribution of Subjects Used in This Study by Deciles of the Stanford Scientific Aptitude Test*

Decile	Number	Per Cent of Total
10th	2	1
9th	7	4
8th	4	2
7th	6	3
6th	13	7
5th	20	10
4th	14	7
3rd	24	13
2nd	30	16
1st	70	37
	190	100

Median of Scores for the Subjects in This Study - 77

Median of Scores for the Standardization Group - 104

*Deciles are those based on scores of 246 unselected college freshmen at Stanford University (59, p.10).

higher scores on the test than this representative local group of college freshmen.

Table XIII shows the test scores required for given percentile ratings according to the distributions of both the standardization group and the group involved in this study. It is apparent that large differences exist at nearly every point along the scale. The extent of this tendency of the test norms may be of considerable value to those using the test with groups similar to the rather representative one of concern in this study.

The Engineering and Physical Science Aptitude Test scores showed correlations with the subject areas varying from .64 to .35, with probable errors from .03 to .06, as shown in Table XIV. The highest correlation, .64, was between the test scores and biological science grade-point averages. It is regrettable that the number of cases available for the calculation of this correlation was only forty, which was the lowest number involved in any of the correlations reported in this study. However, as the probable error of .06 is small, the chance error is not particularly greater than in other studies. The second highest correlation found for the Engineering and Physical Science Aptitude Test was .56 with chemistry grade-point averages. However, the third highest correlation of the test was that of .51 for total grade-point

Table XIII

Scores Required for Given Percentile Ratings on the Stanford Scientific Aptitude Test

Percentile	Study Group**	Standardization Group*
99	155	164
90	115	145
80	102	132
70	93	122
60	84	114
50	77	104
40	71	95
30	64	88
20	57	79
10	50	69
1	39	50

* 246 unselected freshmen at Stanford University (59, p.10).

** 190 unselected Oregon State College freshmen

Table XIV

Correlations Between the Engineering and Physical Science Aptitude Test Scores and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.51	.03	308
Engineering	.39	.04	211
Mathematics	.35	.03	293
Physical Science (Excluding Chemistry)	.43	.04	173
Chemistry	.56	.05	71
Biological Science	.64	.06	40

average, which was higher than the correlations for physical science (excluding chemistry), engineering and mathematics grades. It appears from this study that the Engineering and Physical Science Aptitude Test predicts success in science courses better than it does in engineering and mathematics courses, and that it predicts total grade-point averages better than it does for any of the academic areas tested except biological science and chemistry.

Table XXI in Chapter IV, showing a summary of the obtained correlations, reveals that the Engineering and

Physical Science Aptitude Test had a higher correlation with physical science (excluding chemistry) grade-point averages than any of the other tests involved in the study. It also shows this test to predict total scholastic success as well as the American Council on Education Psychological Examination and better than any of the other tests used in this study. Success in engineering courses is predicted about equally well by the Engineering and Physical Science Aptitude Test and the American Council on Education Psychological Examination Q-score and total score, with correlations around .39.

The correlations found in this study for the Engineering and Physical Science Aptitude Test are somewhat lower than those reported from the standardization of the test (8, p.5).

Table XV shows the distribution of scores for the Oregon State College students taking this test to vary considerably from that of the standardization group. Thirty-two per cent of the 308 Oregon State College freshmen taking this test fell in the highest decile according to the norms published for the test. Eighty-eight per cent of these freshmen were located at or above the fiftieth percentile. The table also shows the median of the local group to be thirty-five points higher than that of the standardization group. It is evident that

Table XV

Distribution of Subjects Used in This Study by Deciles of the Engineering and Physical Science Aptitude Test*

Decile	Number	Per Cent of Total
10th	98	32
9th	69	22
8th	41	13
7th	36	12
6th	28	9
5th	15	5
4th	8	2
3rd	9	3
2nd	2	1
1st	2	1
	308	100

Median of Scores for the Subjects in This Study - 92

Median of Scores from the Published Norms - 57

*Deciles are based upon 6695 male students entering the Engineering, Science and Management War Training Program of the Pennsylvania State College in the spring of 1942 (8, p.8).

Table XVI

Scores Required for Given Percentile Ratings on the Engineering and Physical Science Aptitude Test

Percentile	Study Group**	Standardization Group*
99	139	138
90	120	105
80	113	88
70	105	76
60	98	66
50	92	57
40	83	48
30	74	40
20	65	31
10	55	21
1	28	3

* 6695 male students entering the Engineering, Science and Management War Training Program of the Pennsylvania State College in the spring of 1942 (8, p.8).
**308 Oregon State College freshmen.

Table XVII

Correlations Between the American Council on Education Psychological Examination Total Scores and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.51	.03	362
Engineering	.39	.04	215
Mathematics	.41	.03	325
Physical Science (Excluding Chemistry)	.38	.04	177
Chemistry	.54	.05	99
Biological Science	.43	.06	79

the standardization group made considerably lower scores on the test than the rather typical college freshman group involved in this study.

Table XVI shows the test scores required for given percentile ratings according to the distributions of both the standardization group and the group of this study. The differences are as large as the differences found for the Stanford Scientific Aptitude Test, but they are in the opposite direction. The extent of this divergence from the published norms, as shown in Table XVI,

Table XVIII

Correlations Between the American Council on Education Psychological Examination Q-Scores and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.44	.03	362
Engineering	.40	.04	215
Mathematics	.43	.03	325
Physical Science (Excluding Chemistry)	.31	.05	177
Chemistry	.49	.05	99
Biological Science	.32	.07	79

may be of value in using this test with groups similar to the one involved in this study.

The American Council on Education Psychological Examination total scores used showed correlations with the various subject areas used between .54 and .38, with probable errors from .03 to .06, as shown in Table XVII. This test predicted best for chemistry and second best for total grades, having correlations of .54 and .51, respectively.

Table XIX

Correlations Between the American Council on Education Psychological Examination L-Scores and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.45	.03	362
Engineering	.29	.04	215
Mathematics	.31	.03	325
Physical Science (Excluding Chemistry)	.35	.04	177
Chemistry	.45	.05	99
Biological Science	.43	.06	79

The American Council on Education Psychological Examination Q-scores used showed correlations with the academic areas used varying from .49 to .31, with probable errors from .03 to .07, as may be seen in Table XVIII. This test gave the highest correlations of any of the tests used in this study with both engineering and mathematics grade-point averages, showing coefficients of .40 and .43, respectively.

The American Council on Education Psychological Examination L-scores indicated correlations with the subject areas used ranging from .45 and .29, with probable

Table XX

Correlations Between the Ohio State University Psychological Test Scores and Grade-Point Averages in the Various Academic Areas

Grade-Point Averages	r	P.E.	N
Total Grade-Points	.45	.03	356
Engineering	.23	.04	211
Mathematics	.26	.04	321
Physical Science (Excluding Chemistry)	.36	.04	178
Chemistry	.42	.06	99
Biological Science	.41	.06	76

errors varying from .03 to .06, as shown in Table XIX. This test had its highest relationships with chemistry and total grade-point averages, showing correlations for both areas of .45.

The Ohio State University Psychological Test scores showed correlations with the various academic areas used varying from .45 to .23, with probable errors from .03 to .06, as may be seen in Table XX. The highest correlations for this test were for total grades, chemistry grades, and grades in the biological sciences.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

The results of this study indicated that the best single predictor of total scholastic achievement at the college level was the American Council on Education Psychological Examination total score or the Engineering and Physical Science Aptitude Test score. Both tests showed correlations of .51 with total grade-point averages, as shown in Tables V and XXI.

Physical science (excluding chemistry) grade-point averages in this study were best predicted by the Engineering and Physical Science Aptitude Test scores with a correlation of .43, but it was followed closely by the American Council on Education Psychological Examination total scores with a correlation of .38.

Success in college chemistry courses was predicted quite similarly by the Stanford Scientific Aptitude Test, the Engineering and Physical Science Aptitude Test and the American Council on Education Psychological Examination total score, with respective correlations of .57, .56 and .54.

Biological science grade-point averages were predicted most accurately by the Engineering and Physical Science Aptitude Test scores, with the highest correlation of the study, .64. While the number used in this calculation was small, the probable error was also small and this figure shows some value in this test's scores as predictive measures of success in biological sciences.

Engineering grades were predicted quite equally well by the American Council on Education Psychological Examination Q-score and total score, the Engineering and Physical Science Aptitude Test and the Stanford Scientific Aptitude Test, with correlations of .40, .39, .39 and .37, respectively.

The prediction of mathematics grade-point averages was best accomplished by the American Council on Education Psychological Examination Q-score, but it was closely followed by the American Council on Education Psychological Examination total score, which showed a correlation of .41, just two points lower than the .43 shown by the Q-score.

Summarization of the results of this study, as they apply specifically to the two tests of most concern, shows the Stanford Scientific Aptitude Test to have the highest correlation of any of the tests used in this study with chemistry grades, but its .57 correlation was not significantly above the .56 and the .54 correlations found for

the Engineering and Physical Science Aptitude Test and the American Council on Education Psychological Examination total score. For all the other academic areas in this study the Stanford Scientific Aptitude Test showed lower correlations than either of those two tests. Physical science (excluding chemistry) grades were predicted least accurately by the Stanford Test, as it had the lowest correlation of the entire study, .16. In this study, the Stanford Test predicted general scholastic achievement better than it predicted success in scientific courses, with the exception of chemistry. The standardization group for the Stanford Scientific Aptitude Test made considerably higher scores on the test than did the rather typical college freshmen involved in this study who, in turn, made higher scores on the Engineering and Physical Science Aptitude Test than did the standardization group for that test.

The Engineering and Physical Science Aptitude Test showed the highest correlation of the study, .64, with biological science grade-point averages. It predicted success in chemistry nearly as well as the best predictor in this study, and it forecasted total grade-point averages better than any other test except the American Council on Education Psychological Examination total score, for which the same correlation of .51 was obtained.

Table XXI

Summary of Correlations Between Scores on Selected Tests and Grade-Point Averages in Various Academic Areas

Grade-Point Averages	SSAT	E and PSAT	ACE T	ACE Q	ACE L	Ohio
Total Grade-Points	.39	.51	.51	.44	.45	.45
Engineering	.37	.39	.39	.40	.29	.23
Mathematics	.33	.35	.41	.43	.31	.26
Physical Science (Excl. Chem.)	.16	.43	.38	.31	.35	.36
Chemistry	.57	.56	.54	.49	.45	.42
Biological Science	.37	.64	.43	.32	.43	.41

The Engineering and Physical Science Aptitude Test was the best predictor found in the study for success in physical science (excluding chemistry) courses, showing a correlation of .43. On the whole, this test showed higher correlations with science grades and total grades, than it did with engineering grades. It predicted total grades more accurately than it did either engineering or physical science (excluding chemistry) marks.

Table XXI shows a summary of the coefficients of correlation found in this study between scores on the

selected tests and grade-point averages in the six academic areas used.

Conclusions

In this study the Stanford Scientific Aptitude Test predicted success in engineering and science courses no better than a general scholastic aptitude test such as the American Council on Education Psychological Examination.

The Stanford Scientific Aptitude Test did not appear to differentiate between scientific aptitude and general scholastic aptitude in this study.

The group used in the standardization of the Stanford Scientific Aptitude Test made considerably higher scores on the test than did Oregon State College freshmen. If optimum value is to be obtained from the test, it appears that local norms should be developed or the published norms extended to include enough cases to be representative.

In this study the Engineering and Physical Science Aptitude Test did not appear to predict success in engineering and physical science courses any better than a general scholastic aptitude test such as the American Council on Education Psychological Examination.

The Engineering and Physical Science Aptitude Test did not, in this study, differentiate between engineering and physical science aptitude, on the one hand, and general scholastic aptitude, on the other.

This study indicates that the Engineering and Physical Science Aptitude Test predicts science grades more accurately than it does engineering marks.

This study indicated success in biological sciences to be predicted somewhat more accurately by the Engineering and Physical Science Aptitude Test than by other tests available in the field.

The group used in the standardization of the Engineering and Physical Science Aptitude Test made considerably lower scores on the test than did the Oregon State College students. If optimum use is to be made of this test, norms for local situations might well be developed or the published norms extended to include enough cases to be representative.

The tests used in this study were found to have significantly different predictive values for the various academic areas. Success in chemistry courses was predicted in this study by the Stanford Scientific Aptitude Test and the Engineering and Physical Science Aptitude Test as accurately as most tests available in the field as shown by other studies. In this investigation, biological

science grades were predicted by the latter test more effectively than by most of the other tests in that area as shown by other studies. On the other hand, success in courses in engineering, mathematics and physical science (excluding chemistry) appears, from this study, to be predicted more accurately by other tests than either the Stanford Scientific Aptitude Test or the Engineering and Physical Science Aptitude Test.

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