

THE USE OF THE IOWA PHYSICAL SCIENCE APTITUDE TEST
IN THE PREDICTION OF SUCCESS IN THE SCHOOL
OF ENGINEERING AND ARCHITECTURE
OF KANSAS STATE COLLEGE

by

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B. S., Kansas State College
of Agriculture and Applied Science, 1947

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1952

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INTRODUCTION

Purpose of the Study

The purpose of this study is to report the results obtained from a study of the Iowa Physical Science Aptitude Test as a predictive index for the School of Engineering and Architecture.

In the Kansas State College School of Engineering a freshman's chance of graduating is on the whole a little better than one out of four. Dean Durland reported orally to the author that the School of Engineering normally expects about 15 per cent of an entering class to graduate in engineering after eight semesters and about 15 per cent to graduate at a later date. This fact points up the importance of improved counseling techniques, of which prediction studies are of primary value. Generally speaking, 20 out of every 100 high school graduates in the United States now enter some institution of higher learning, but only 10 of these ever receive a Bachelor's degree. What is the reason for this large student mortality? Can college success; that is, satisfactory academic achievement, be predicted? If so, what is the best predictive index? How reliable is it? When should it be applied? These are questions which prompted the writer to investigate the problem of prediction for engineering schools in general, by reviewing previous research in engineering schools where

such indices as (1) General Scholastic Aptitude Tests; (2) Achievement Tests; (3) Spatial Relations Tests; (4) Tests of Mechanical Aptitude; (5) Engineering Aptitude Tests and (6) combinations of the above. More specifically, the Iowa Physical Science Aptitude Examination was investigated as it was the index used at Kansas State College in the fall semester of 1950. The Iowa Physical Science Aptitude Test was introduced into the battery to replace the Cooperative General Mathematics Test form QR. The fact that the test yields four subtest scores was an attractive feature since it might provide diagnostic information useful in guidance. The fact that the authors had found a correlation of .707 between scores on the mathematics subtest and success in mathematics suggested that it might perform the same function as the Cooperative Mathematics Test. All previous studies in which this index was used for prediction were reviewed, as research on the instrument is very limited.

The first and major purpose of the study was to see how closely the Iowa Physical Science Aptitude Test correlated with grade point average after one semester of work in engineering. The total and sub-scores of the Iowa Physical Science Aptitude Test were also correlated with letter grades in College Algebra, Plane Trigonometry and Chemistry EI.

It was also deemed advisable to compare the effectiveness of the American Council on Education Psychological Examination which was already in the battery of tests given to freshmen

entering Kansas State College. This test was also correlated with grade-point average, and letter grades in College Algebra, Plane Trigonometry and Chemistry EI. The ultimate purpose of this comparison was to determine if the introduction of the Iowa Physical Science Examination as a predictive index was justified or if the American Council on Education Psychological Examination might not be used for the same purpose.

While studying the Iowa Physical Science Aptitude Examination and the American Council on Education Psychological Examination as predictive indices, the author decided to investigate those students whose high school rank had been indicated on their high school transcripts.

Need for the Study

Perhaps the most important need for the study was to provide counselors in the Student Counseling Bureau with means of prediction. It is the task of the counselor to predict status or level of achievement of the counselee and this study was concerned with the importance of providing such tools for the use of the counselors. The student must understand the predictive information and incorporate it into his thinking to arrive at a satisfactory conclusion. Stuit et al. (7) in his book Predicting Success in Professional Schools has said: "Counselors are more and more coming to realize that the predictive efficiency of suitable tests given at the beginning of

the freshman year furnish a reliable basis for the formulation of methods of imparting test information to freshmen engineers." Many students for various reasons have come to the Counseling Bureau seeking help toward establishing an educational objective or making a curriculum change. Prediction through locally established correlation coefficients will provide a more accurate and realistic situation for these students. Counselors must for this reason have available predictive indices of known accuracy and of contemporary value.

The logic of prediction is applied to give a clearer understanding of what is accomplished in measurement. In measuring or grading a student in a particular course it is determined whether he will do well in an engineering curriculum. Will he succeed in the next course or in the vocation of engineering? Should he elect another major or drop out of school? What is the level of training which should be applied? What type of counseling will be most appropriate? What is the prognosis? The logic of prediction is applicable to all these questions. The particular aptitude test which is used will have meaning only when it will predict behavior in terms of what the student will be doing in his more advanced engineering courses. The counselor attempts to predict many things to come for each student. Forecasting success in a particular choice if all important for the individual student.

Psychological measurement functions in the counseling process as a means to an end: to help identify those individual

strengths and weaknesses within an individual and between individuals; to provide insight and understanding for the student and counselor; to structure diagnostic descriptions of an individual; and to permit more accurate predictions than would be possible otherwise.

In the total process of counseling students it is necessary to get answers to questions about the student's chances of success in a given task in a curriculum or vocation. The Student Counseling Bureau is concerned with measurement as an aid in helping the individual student find the vocation, college curriculum, and the general social environment which will make for his successful adjustment. The task may be better achieved by visual aids such as prediction tables, the use of which is facilitated by local correlation coefficients such as is found within this study.

A need was recognized for a predictive instrument in the field of engineering and it was decided to investigate the value of the Iowa Physical Science Aptitude Examination. The study was also needed to provide further research on this test. Coefficients were based on a single sample of 188 Iowa and Pennsylvania State College students. While these correlations do indicate the value of the test, they can only be taken as presumptive evidence. No reliability coefficient was reported for the number series subtest, and for the total test only an estimate is available. Reliabilities are reported for the subtests in mathematics, formulation and information as .90,

.68, and .87, indicating reasonable reliability for the subtests.

The Iowa Physical Science Aptitude Examination was designed to measure the individual's aptitude for the study of mathematics and the physical sciences and to predict his chances for success in work of a technical or engineering nature. Specifically, the authors of the test claim the Iowa Physical Science Aptitude Examination can be used to (a) afford a basis for the prediction of the level of work a student will accomplish in physical sciences, (b) aid in selecting and admitting individuals to technical and engineering courses of study, (c) section classes for instructional purposes, (d) assist individuals who are not well oriented to their academic work, (e) assist individuals in deciding how much work should be carried and (f) furnish a basis for the diagnosis of class weaknesses (23).

The examination was printed in 1943, however, it does not contain new material but has a reprinting of three subtests from the 1941 revised edition of the Iowa Physics Aptitude Test. The Iowa Physics Aptitude Test was originally published in 1925 and a revised form was issued in 1941. The test is designed to measure fundamental abilities which research has shown to be related to the successful pursuit of scientific and technical subjects. The four subtests may be described as follows (23):

1. Mathematics. This subtest contains twenty items requiring simple algebraic skill and five others involving a knowledge of decimals, percentages and square root. It samples the student's ability to handle common arithmetic and algebraic skills, and is composed of items requiring the mathematical skill needed for successful work in physical science.

2. Formulation. This subtest includes 22 statements of quantitative relations expressed verbally for which the appropriate algebraic expressions are to be written.

3. Number Series. This subtest includes 20 sets of numbers developed according to rules which the individual must determine to answer them correctly. It proposes to measure the students' ability to think deductively.

4. Information. This subtest is composed of 75 true-false items which provide "a measure of the individual's familiarity with the general principles of physical science." This subtest is thought to be heavily affected by previous pursuit of courses in physical sciences in high school.

Validity data are reported comparing scores made on the various parts of the test with grades in college courses. The manual states that "to date (1943) the validity of the test has been studied only in the prediction of success in the physical sciences."

The validity of the total test score is not known, but the manual reports that reliability for the total test is .95 (23).

There is no mention of the method used in obtaining the reliability coefficients which are calculated for the three parts. Percentile norms were based on 446 cases. A report of tests on 168 meteorological men was made, and the manual stated that the percentile scores made by this group were strikingly higher than these made by the "ordinary college population."

Each of the subtests has its own time limit and is scored separately. The total score consists of the sum of the appropriately weighted part scores. It was suggested by the authors that the total scores could be used for screening or prediction purposes.

The test was designed for use primarily with persons who have had training comparable to that of a high school senior or college freshman. The manual states that generally a person who has had extensive training in mathematics and physical science could be expected to do better in the test than one who has had no training in these subjects.

REVIEW OF PREVIOUS WORK IN PREDICTING SUCCESS IN SCHOOLS OF ENGINEERING

In order to present a more concise and meaningful review of previous work in predicting success in schools of engineering, the author has prepared an Appendix. Referral to specific studies may be found in the References.

The problem of predicting students' success in schools of

engineering has probably been studied more extensively than that of any other area and the efforts have been quite successful. The types of tests most frequently used, aside from those of general scholastic aptitude, are mathematical achievement or aptitude, spatial relations, and mechanical knowledge. The study by R. L. C. Butsch (12) at Marquette University in 1939 shows the need for each school to find its own correlation coefficient between college marks and every other prognostic factor.

Previous studies which were reviewed by the author consistently point to the previous scholarship as one of the best single measures which may be used in predicting the individual's chances for successfully completing a course in engineering.

The criterion employed in most of the studies referred to in the Appendix; namely, first-year achievement, appears to be a suitable one, because of the significant degree of correlation between the first-year record and performance in the advanced years of engineering.

General Scholastic Aptitude

Scholastic aptitude test scores represent a good predictive index for the first year of college engineering as indicated in the Appendix. Durland (16) found that a student in the highest fifth on mental tests has almost seven times as good a

chance of finishing as one in the lowest fifth. Validity coefficients on scholastic aptitude tests vary from zero to as high as .70, with the median correlation of .45 when using freshman grades as the criteria. Derflinger (14) summarized individual studies reporting correlations between intelligence and college marks and found a median of .52 for the relationship in 47 studies reported since 1934.

The scholastic aptitude type of test is ordinarily used to predict over-all success in college. However, in those cases where the test yields both a linguistic and a quantitative score, some differential prediction may be possible if the two scores are treated as separate observations of the student.

Achievement Tests

Achievement tests may serve as important supplements to measures of scholastic aptitude, since they operate on the principle that a reliable and unbiased measure of past performance in a given area provides one of the best means for predicting future performance in the same area. In achievement tests considerable variation in predictive value is found because of variation in such factors as: the appropriateness of the test, the range of talent in the group studied, and the method of measuring college success. It was pointed out by Crawford and Burnham (2) in their studies at Harvard and Yale

that the prediction of success in a particular course from the appropriate achievement test may be somewhat better than the general prediction. This was particularly true of physical science and mathematics. Other studies in English and science followed much the same trend as those of mathematics achievement tests. Scores on achievement tests in science, and especially in the field of physics, should be given consideration when counseling the individual student.

English proficiency was treated in many of the studies, and the importance of verbal fluency and its relationship with scholastic achievement was emphasized.

Spatial Relations

Another aptitude required in many engineering courses, particularly mechanical drawing and descriptive geometry, is the ability to think in terms of three dimensional space. A number of spatial relations tests have been developed and used in the attempt to measure this important ability.

Mechanical Aptitude

Mechanical aptitude could not be overlooked in the prerequisites for success in engineering. In general, the studies seem to indicate that scores made on the tests involving visualization of spatial relations or the basic principles underlying

mechanical operations are significantly correlated with achievement in engineering studies. It was thought that manipulative skill was less important in predicting success of a professional nature. Tests of mechanical aptitude or comprehension seem to have some value in selecting men for vocational training; they have received relatively little attention from engineering schools however.

Engineering Aptitude

A number of tests of science or engineering aptitude have been developed for use at the college level. Zyve's Stanford Scientific Aptitude Test was thought by Chauncey and Frederiksen of the Educational Testing Service (1) to be inadequately standardized and validated, and they state that the tests "are of limited value, although certain of the materials seem promising." The subsections of this test are too short to yield reliable measures of the various aspects of aptitude and achievement which they are intended to measure." (1). The Pre-Engineering Inventory developed by the Measurement and Guidance Project in Engineering Education was said to have good predictive value by Chauncey and Frederiksen (1). The Pre-Engineering Inventory was administered in a twelve school study and it was concluded that on the whole it performs satisfactorily as a predictory. Composite scores best represent a general verbal and quantitative aptitude score (1).

Combinations

When combinations of predictive indices were investigated, it was found that no single variable seems to be so consistently and significantly correlated with achievement in engineering school that reliance upon it alone as a basis for prediction for an individual may be justified. The most efficient combination of predictive indices to be used in estimating an individual's chances for success in the study of engineering according to Stuit et al. (7) appears to be one comprising (a) previous scholastic record (high school or college), (b) scholastic aptitude test scores, and (c) scores obtained on subject-matter achievement tests in the areas of mathematics, science and English.

It has been repeatedly demonstrated that a combination of several indices is more accurate in predicting college scholastic success than any single variable alone. A. E. Crawford (13) working at Yale, found a multiple correlation of .74 between college scholarship and a combination of College Entrance Examination Board tests, High School Record, an Interest Test and age at entrance. Segel (29) made a summary of a series of studies which led to the following conclusions (1) Multiple correlation coefficients are rarely higher than .80 regardless of the variables used; (2) An intelligence test, a good achievement test and high school grade averages together usually bring the highest multiple correlations;

(3) The median multiple correlation, as found in the summaries is between .60 and .70. This is better than for single tests.

REVIEW OF PREVIOUS RESEARCH WITH THE IOWA PHYSICAL SCIENCE APTITUDE TEST

The Iowa Placement Examinations were constructed by Dr. George D. Stoddard under the general direction of Dean C. E. Seashore of the Graduate College of the State University of Iowa and Professor G. M. Ruch of the College of Education of that institution. Assistance in preparing the examinations was given by members of the faculties of the several departments of instruction to which the examinations relate. The Society for the Promotion of Engineering Education (19) cooperated in having the examinations given to students and assisted in securing their scores in the examinations and grades in corresponding subjects of the freshman year.

The institutions which participated in the trial of the examinations of the years 1924-25 and 1925-26 furnished a representative sample of the engineering colleges of the country. The institutions were well distributed in the various parts of the country, with a preponderance of institutions in the Middle West.

The numbers of students taking the various examinations ranged from over 8,000 in the English Aptitude Test to about 1,300 in the Physics Training Test.

The report of Dr. Charles R. Mann (26) in Engineering Education discusses the special tests of engineering aptitude constructed by Professor E. L. Thorndike. This report had considerable effect in promoting the use of special tests of various kinds. It was Dr. Mann's report which led directly to a trial of special forms of examinations by a considerable number of engineering colleges pursuant to the following resolution passed by the Society at its annual meeting in 1919 (19):

...That this society through its Committee on admission or otherwise, recommends that as a matter of experiment and research, psychological 'objective', 'trade', or other similar tests be given to all students after admission to engineering courses of study and that the ratings thus obtained be compared with their subsequent scholastic progress.

In accordance with that resolution, six tests were prepared under the direction of Professor L. L. Thurstone and a special committee of the Society and were administered to over seven thousand students at the time of their admission to engineering colleges. This was a part of the general movement in higher education toward objective evaluation of student abilities and performances.

The earlier Iowa Placement Examinations were divided into two parts, one a test of aptitude and the other a test of training. The tests were designed to furnish a prediction not only of quality of scholastic work in general but also of work in particular subjects. Correlations were from 0.65 to 0.75 for general academic work of the first semester

of the freshman year with the original Iowa Placement Examinations, Form A, in 1928.

As previously stated, the Iowa Physical Science Aptitude Test was printed in 1943, but does not contain new material. It is a reprinting of three subtests from the Iowa Physics Aptitude Test and one subtest from the Iowa Mathematics Aptitude Test. The Iowa Physics Aptitude Test was originally a part of the Iowa Placement Examinations discussed above. It was originally published in 1925 and the revised form was issued in 1941. The Iowa Mathematics Aptitude Test was first published in 1925 and the revision was printed in 1942.

METHOD OF PROCEDURE

In the fall of 1950-51, during freshman orientation week, the Iowa Physical Science Aptitude Test was administered to all entering freshmen in the School of Engineering and Architecture with the exception of those students enrolling in Chemical Engineering who were given the Iowa Chemistry Aptitude Test instead. The problem of this study was to determine the relationship between scores made on a special aptitude test, the Physical Science Aptitude Test, on the one hand and a Scholastic aptitude test, the American Council on Education Psychological Examination, 1945 edition (local norms), on the other, with letter grades which had already been earned in the first semester for several subject matter courses at the

college level. These courses were College Algebra, Trigonometry and Chemistry EI. These two tests were also correlated with total grade-point average after one semester of work. The subjects used in the study were all freshmen entering the School of Engineering and Architecture in the fall of 1950. There were 136 students involved in the study, all but one being male.

The final letter grades for College Algebra, Plane Trigonometry and Chemistry EI were compared with the Iowa Physical Science Aptitude Test results through the use of the Pearson product-moment method of computing the coefficient of correlation, and are uncorrected for attenuation. Not only was this comparison made using the total raw score versus final grades, but it was also made for the raw scores on each subtest as opposed to final grades. A similar comparison was made of final grades and total raw scores and subtest raw scores on the American Council on Education Test.

The problem of correlating high-school rank with grade-point average after one semester was also undertaken. There were 89 students involved in this study whose high school principals had added their high school rank and the number of high-school students in their respective graduating classes to their high school transcript. High school rank percentiles and scale scores were computed by the Hull method (5) for these students.

The number 89 was later reduced to 72 in order to exclude those students who had not taken the Iowa Physical Science

Aptitude Test. A comparison study was made and high school rank, the American Council on Education Psychological Examination and the Iowa Physical Science Aptitude Test were correlated with grade point average. A multiple correlation study was completed to determine the most effective combination of these variables for prediction purposes.

Averages as computed followed this pattern: In computing grade point averages at Kansas State College, three grade-points are assigned for each credit at the grade of A, two for each grade of B, one for each grade of C, Zero for each grade of D, minus one-half for each condition grade and minus one for each grade of failure. Therefore, a B average was considered as 2.00-2.99, C as 1.00-1.99, D as 0.00-0.99 and Fail as -.01 to -1.00.

Since Kansas State College is required by law to accept all of the students who have been graduated from an accredited High School in Kansas, there is the particular problem of taking care of those students who are unable to cope satisfactorily with college work. In general, predictions of college achievement from high school achievement have been found to be fairly accurate; but predictions based on average grades are inferior to predictions from rank-in-class, in relation to the size of the class. The reason is that variations occur in standards and in marking systems from school to school, which are uncorrelated with the ability level of the students or with subsequent measures of success

in college.

Rank in class is more predictive than average grade because it eliminates some of the variability due to the differences in grading procedures. It can be used in raw form only for classes of the same size or it can be reduced to percentile rank by computing the ratio of standing in class to the size of the class. The latter method was used by the author since the percentile rank is more convenient and meaningful than the "raw" rank and permits a more direct comparison of students from classes of different size. For use statistically, the percentile rank was converted to a standard score on a sigma scale. The formula: $\text{Percent position} = \frac{100(R-.5)}{N}$ was used. R = Rank of the individual in the class. N = Number of cases. The Percent position was then converted into T scores or units of amount on an ordinary scale of ten points.

It would seem that the prediction of academic success in college on the basis of high school record is fairly successful because of the similarity of the two situations involved.

In predicting scholastic achievement from sigma scores based on rank-in-class, and class size, other variables, such as differences in schools, with regard to the average quality of instruction, must be taken into consideration. The high school may have used different methods of reporting students tied for the same position. In spite of all these difficul-

ties, Chauncey and Frederiksen (1) report that it is usually the best single predictive index available to the college admissions officers. They state that correlations of the order of .55 are commonly found between rank in class and measures of achievement in college. Drake and Henmon (15) showed that combinations containing the factor high school percentile rank, are more effective than any of the other possible combinations; but more significantly, those combinations not containing high school percentile rank as a factor predict grade-point average less efficiently than the single factor of high school percentile rank alone does.

RESULTS AND DISCUSSION

The results of statistical analysis of data collected concerning the Iowa Physical Science Examination are found in Table 1.

Reading from Table 1, Formulation seems to be the most important subtest for College Algebra, with a correlation of .484. Science Information with a correlation of .538 and Formulation with a correlation of .533 seem to be important factors in success in Engineering Chemistry EI. Science Information with a correlation of .538 is most important in predicting success in Chemistry EI as would logically be expected. The Number Series subtest of the Iowa Physical Science Aptitude Test seems to have little predictive and guidance value for use with Engineering students.

Table 1. Correlations of the Iowa Physical Science Aptitude Examination total raw scores and subtest raw scores vs. final total grade-point average and final letter grades in College Algebra, Plane Trigonometry and Chemistry EI. The number of students involved in each correlation is included.

IPSAT	: N=105 : G.P.A.	: N=72 : Col. Alg.	: N=66 : Plane Trig.	: N=77 : Chem.EI
Mathematics	.473	.350	.383	.483
Formulation	.436	.484	.402	.533
Number Series	.206	.107	.129	.155
Science Inf.	.456	.329	.183	.538
Total	.510	.318	.295	.533

The results of statistical analysis of data collected concerning the American Council on Education Psychological Examination are found in Table 2.

Reading from Table 2, certain features are at once evident from an examination of the table. With the exception of Plane Trigonometry, linguistic ability seems to be at least as important as quantitative ability for success in the first semester of the engineering curricula.

Both tests predict better for Chemistry EI, ($r=.428$) than for either College Algebra, ($r=.218$) or Plane Trigonometry ($r=.316$).

Table 2. Correlations of the American Council on Education Psychological Examination total raw scores and its subtest raw scores vs. final first semester grade-point average and final letter grades in College Algebra, Plane Trigonometry and Chemistry EI. The number of students involved in each correlation is included.

A.C.E.	N=130	N=82	N=71	N=71	N=91
	G.P.A.	Col. Alg.	Plane Trig.	Chem. EI	
Quantitative	.424	.203	.275	.302	
Linguistic	.491	.288	.252	.371	
Total	.555	.218	.316	.428	

High School Rank was chosen as a predictor of grade point average and a sample of 72 students whose high school principals had indicated their rank in class was used. Previous studies at Kansas State College had revealed good correlation between this predictor and grade point average. Adell (8) analyzed the records of 372 graduates of Manhattan High School who entered Kansas State College from 1924 to 1929, inclusive. Adell found a correlation of .74 between average high school grades and average first semester college grades.

The results of the further investigation of High School Rank, the American Council on Education Psychological Examination and the Iowa Physical Science Aptitude Examination as predictors of grade point average may be seen in Table 3.

Table 3. Variables with intercorrelations and multiple correlations for 72 students.

Variables	
1	= grade point average
2	= high school rank
3	= Iowa Physical Science Aptitude Examination
4.	= American Council on Education Psychological Examination
Intercorrelations	
r_{12}	= .667
r_{13}	= .481
r_{14}	= .499
r_{23}	= .245
r_{24}	= .382
r_{34}	= .649
Multiple correlations	
R_1	(23) = .743
R_1	(24) = .717
R_1	(234) = .748

SUMMARY AND INTERPRETATION

The study began with the purpose of finding what value the Iowa Physical Science Aptitude Test had in predicting success in Engineering in terms of total grade point average and letter grades in engineering courses after one semester of work. There were 105 students involved in this study. The results are given in Table 1.

The American Council on Education Psychological Test form 1945 was then used as a supplementary predictive index and correlated with the same criteria. There were 130

students in this sample. The correlations are given in Table 2. The correlation coefficients of these two tests were not directly comparable, due to the difference in numbers of students involved.

At this point, high school rank was taken as a third predictive index and added to the study. Although the study began with the purpose of finding the value of the Iowa Physical Science Aptitude Test with a sample of 105 students, the sample was reduced to 72 to include only those students who had taken both the Iowa Physical Science Aptitude Test and the American Council on Education Psychological Test and who had high school rank indicated in their record. When the study was reduced to a population of 72, and intercorrelations of the criterion grade point average and each of the variables as predictors were calculated, the correlations were not significantly different at the 5 per cent level of confidence, due possibly to the fact that they are approaching the ceiling and to the small N. This may be seen in Table 3.

Obviously there is no correlation between grade point average and each of the two aptitude tests, r_{13} and r_{14} , however, the difference between the correlation of grade point average and high school rank is considerably higher than each of the two aptitude tests. Even this large difference is not significant at the 5 per cent level of confidence.

The multiple correlation coefficient shows a difference between the Iowa Physical Science Aptitude Test and the

American Council on Education Psychological Test. This difference, however, is not significant at the 5 per cent level of confidence.

Again, this lack of statistical significance may be due to the small number, or to the close approach of these correlations to the ceiling imposed by the unreliability of the criterion of grade point average.

When these predictors are combined, the correlation is raised slightly. Off hand, it may be seen that both tests need not be included because of the slight difference as shown by the multiple correlations for the three predictors, as compared with those of the two predictors. What advantage there is, is on the side of the Iowa Physical Science Aptitude Test.

Whenever talking about measuring for prediction, one must not overlook the fact that there is an unpredicted variance in average college grades which usually amounts to approximately one-half of the total variance. This unpredicted portion is due largely to factors such as persistence, motivation, personal adjustment, interest, and study methods, as well as variable factors in the test situation. This condition was mentioned by most of the writers and must be taken into consideration. However, prediction in terms of less tangible indices, such as personality and adjustment, is as yet quite unsatisfactory.

Invalid grades are also thought to be a reason for the

poor predictive value of tests when predicting grade point average. Durflinger (14) in the Journal of the American Association of Collegiate Registrars has said:

It is becoming clearer that one reason for unreliable prediction resides in invalid and unreliable grades given by instructors. We cannot hope for valid and reliable prediction when the thing we are predicting is, itself, unreliable and invalid, or illy defined. Until we have reliable and valid measures of achievement, therefore, we cannot have reliable and valid prediction.

CONCLUSIONS

1. As single predictors of total grade point average, no difference was found between the two tests.
2. Correlations of letter grades in different engineering subjects with scores on each of the two tests were no better than those with total grade point average and frequently smaller.
3. High school rank correlated .667 with grade point average and was better than either the American Council on Education Psychological Examination or the Iowa Physical Science Examination; but the difference was not statistically significant at the 5 per cent level of confidence.
4. When each of these aptitude tests, the Iowa Physical Science Aptitude Test and the American Council on Education Psychological Examination is combined separately with high school rank to predict college grade point average by means

of multiple correlations, the predictions are considerably though not significantly improved.

5. When scores from both tests are combined with high school rank for predicting college grade point average, the multiple correlation coefficient is raised so slightly that it is not considered advisable to include both.

SUGGESTIONS FOR FURTHER RESEARCH

There seems to be a need to continue this study by considering the value of high school rank as a predictor of success in engineering, since most of the studies revealed it to be the best single predictor of success in Engineering. A regression study could be made using high school rank and either of the two aptitude tests to predict grade point average after one semester. Such a study could be made separately for each of the two tests as related to grade point average for students in separate engineering curricula.

The reason for drop-out could be considered for this particular group, especially for the highly gifted individuals.

It would be well for the Counseling Bureau to consider the preparation of cumulative prediction tables for each class, predicting grade point average for a single individual from multiple correlations such as those mentioned in this study.

ACKNOWLEDGMENT

The writer wishes to express sincere appreciation to Dr. J. C. Peterson, major instructor, for the assistance, guidance and helpful criticism which he has extended during the research and writing of this thesis.

The writer also wishes to express her gratitude to Assistant Professor Henry Tucker for his advice as to statistical procedures and interpretations.

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APPENDIX

Review of Previous Work in Predicting Success in Schools of Engineering

Investigator	Date	Predictive Index (Rank)	Criterion	N	r	P.E.
(17)	1937	High School Average	First Semester Grades Fresh. Year	1,275	.42	.02
(24)	1939	Average grade - 12 marks	First-year Average	144	.61	.03
(12)	1941	Rank in H. S. Class	First Semester Grades Fresh. Year	132	.60	.04
(10)	1944	Percentile Rank, H.S. Class	First Year Honor Point Ratio	154	.56	.04
(16)	1948	H. S. Rank	First Semester Average	1,189 (men) 500 (women)	.58 .62	.01 .02
(Previous Work)						
(21)	1932	First-year Honor-point Ratio	Honor-point av. for all courses taken beyond first year	107	.61	.04
(20)	1933	First-year Math. Av.	Four-year Av.	153	.84	.02
(11)	1941	First-Semester Av.	Four-year G.p.a.	104	.91	.01
(25)	1942	First Two Years G.p.a.	Last Two Years G.p.a.	583	.70	.01

Investigator	Date	Predictive Index (Schol. Apt.)	Criterion	N	r	P.E.
(21)	1932	ACE Psych. Exam.	First Year Gr.	(n.r.)	.55	
(12)	1939	ACE Psych. Exam.	First Sem. Gr. Fresh. Yr.	333	.48	.03
(24)	1939	ACE Psych. Exam.	First Year Gr.	144	.34	.05
(25)	1943	ACE Psych. Exam.	First Yr. Grade Point Av.	.383	.48	.03
(10)	1944	ACE Psych. Exam.	First Year Honor Point Ratio	154	.21	.05
(Math. Achiev.)						
(28)	1936	Cooperative Math. Test	First Year Av.	4,900	.57	.01
(12)	1939	Iowa High School Content Exam. Math.	First Semester Grades Fresh. Year	132	.52	.04
(18)	1939	Iowa Placement Exam. Series: Math. Training	First-Semester Grade-point Av.	99	.72	.03
(10)	1944	Coop. Math. Test	First-year-honor- point ratio	154	.45	.04
(Science Achiev.)						
(12)	1939	Iowa High School Content Exam.: Science Section	First Semester Grades	132	.43	.05
(10)	1944	Cooperative Chemistry Test	First Year Honor Point Ratio	497	.34	.03

Investigator	Date	Predictive Index (English Achiev.)	Criterion	N	r	P.E.
(28)	1936	Coop. English P.M.	First Year Av.	4,900	.45	
(18)	1939	Iowa Placement Exam. Series: Eng. Trng.	First Year Grade Point Average	84	.60	.05
(25)	1943	Cooperative English Fm. OM	First-year honor- point ratio	383	.46	.03
(10)	1944	Cooperative Eng. PM	First-year honor- point ratio	154	.28	.05
(General Achiev.)						
(18)	1939	Iowa High School Content Exam.	First-year grade- point average	84	.69	.04
(Spatial Rel. & Mech. Abil.)						
(21)	1932	MacQuarrie Test for Mech. Abil. Total	First-year Average	104	.48	.05
(12)	1939	MacQuarrie Test for Mech. Abil. Total	Four-year Grade point average	104	.22	.06
(25)	1943	Engineering and Physical Science Apt.	Final Grade, five introductory Eng. subjects	188	.73	.02
(10)	1944	Revised Minnesota Paper Form Board	First-year honor point ratio	497	.22	.03

Investigator	Date	Predictive Index	Criterion	N	r	P.E.
(21)	1932	Strong Vocational Interest Blank. Eng. Key	First year Grades	270	.18	.04
(10)	1944	Strong Voc. Int. Eng. Key	First-year honor point ratio	154	.13	.05
(22)	1929	Average of High School grades with the Thorndike Intelligence Examination (Others)	First Semester Col. Grades		.69	
(8)	1931	Average high school Grades. Schools outside Manhattan	First Semester Col. Grades	372	.57	.02
(3)	1931	Average high school Grades, Manhattan High School	First Semester Col. Grades	372	.74	.02

THE USE OF THE IOWA PHYSICAL SCIENCE APTITUDE TEST
IN THE PREDICTION OF SUCCESS IN THE SCHOOL OF
ENGINEERING AND ARCHITECTURE OF
KANSAS STATE COLLEGE

by

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B. S., Kansas State College
of Agriculture and Applied Science, 1947

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1952

PURPOSE

The purpose of this study was to report the results obtained from a study of the Iowa Physical Science Aptitude Test as a predictive index for the School of Engineering and Architecture. There were 136 Fall of 1950 Engineering students involved in the study.

The literature of previous prediction studies in the field of Engineering was reviewed and a summary may be found in the Appendix. Research for the Iowa Physical Science Aptitude Test was specifically reviewed.

PROCEDURES

The procedure or method used in approaching the problem was in essence as follows: (1) The first and major consideration was to see how closely the Iowa Physical Science Aptitude Test correlated with grade point average after one semester of work in Engineering. The total and sub-scores of the Iowa Physical Science Aptitude Test were also correlated with letter grades in College Algebra, Plane Trigonometry and Chemistry EI. (2) It was also deemed advisable to compare the effectiveness of the American Council on Education Psychological Examination with the same criteria. (3) High school rank was adopted as a third index of prediction and a comparison study was made using high school rank, the American Council on Education Test and

the Iowa Physical Science Aptitude Test as separate indices of prediction of grade point average. (4) Multiple correlations were completed to determine the most effective combination of these variables for predictive purposes.

RESULTS

Scores of each of these aptitude tests were combined with high school rank to find the multiple correlations of the two predictors with college grade point average. The resulting multiple correlation coefficients of the Iowa Physical Science Aptitude Test plus high school rank vs. grade point average was .743 and the American Council on Education Psychological Test plus high school rank vs. grade point average was .717. This difference of .026 was not statistically significant, perhaps because of the small number of students involved in the study or the close approach to the ceiling imposed by the unreliability of the criterion of grade point average, or a combination of these factors with others that are unknown.

When the three predictors are combined to forecast grade point average, the multiple correlation rises to .748 which is only .005 higher than the best of the previously mentioned combination of two predictors.

CONCLUSIONS

1. As single predictors of total grade point average, no difference was found between the two tests.

2. Correlations of letter grades in different engineering subjects with scores on each of the two tests were no better than those with total grade point average and frequently smaller.

3. High school rank correlated .667 with grade point average and was better than either the American Council on Education Psychological Examination or the Iowa Physical Science Examination; but the difference was not statistically significant at the five per cent level of confidence.

4. When each of these two aptitude tests is combined separately with high school rank to predict college grade point average by means of multiple correlations, the predictions are considerably though not significantly improved.

5. When scores from both tests are combined with high school rank for predicting college grade point average, the multiple correlation coefficient is raised so slightly that it is not considered advisable to include both.