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## The Selection of Science Students at the College Level

JOHN L. HOLMES

In predicting scholarship in college practically every known fact about a student has been studied in an effort to find the variables most predictive of success. Age, height, weight, religion, father's occupation, education of parents, and size of family have been extensively used to predict college success.

Prediction through the use of tests has been studied in practically every college from the smallest junior college to the largest universities. The interest, and it has been tremendous, shown in the prediction of college success is closely related to the progress made in devising more accurate measurement devices. Beginning in 1917 with the mental testing of World War I servicemen, the testing movement with its increasing number and types of tests gave the colleges the evidence needed for prediction studies. Quickly following the development of mental tests came tests of personality, vocational interest, and specific aptitudes. The advances made in objective or new-type test construction led to widespread use of this type of test for measuring achievement at all educational levels.

Many privately endowed and some state-supported institutions are now using elaborate test batteries in selecting their students. Most colleges use the test evidence obtained during freshman week for classification and placement after entrance. A great majority use the results for purposes of guidance after the student has begun his college work. Regardless of the use to which the evidence is put, the problem of prediction is the major reason for using pre-college testing and counseling.

At the Iowa State College we have ample evidence of the need for prediction of success. For a group of students enrolled in the Division of Science studied prior to World War II, we have the following information:

- 22% changed their choice of curriculums at least once.
- 42% graduated after 12 quarters in college.
- 42% dropped voluntarily from college and never returned.
- 15% were dropped because of low scholarship.
- 50% did not have a definite vocational choice at the time they entered college.
- 35% with high school averages between 3.6 and 3.9 did not graduate.
- 40% with high school averages between 1.2 and 1.5 did graduate.
- 18% with intelligence test scores in the top ten percent did not graduate.

- 20% with intelligence test scores in the bottom twenty percent graduated.
- 22% with high school averages between 1.2 and 1.5 made cumulative college grade point averages of 2.0 or better.
- 5% with intelligence test scores in the low ten percent made cumulative grade point averages of 2.0 or better.
- 14% with first quarter averages between 0.8 and 1.1 made cumulative averages of 2.0 or better.

Certainly, with such evidence before us, the possibilities of accurate prediction of success for individual students at Iowa State College are not too good, unless we use more or better variables.

My purpose in presenting this paper is two-fold. First I want to review the work that has been done in the prediction of success. In doing this, only factors that have shown the greatest promise will be considered. These are intelligence, achievement, interest and personality test scores, grades in high school, patterns of high school courses, and various combinations of these factors. My second purpose is to give a progress report on the prediction work under way at the Iowa State College.

#### I. *Prediction of General College Scholarship*

**Intelligence (Scholastic Aptitude) Tests.** There have been few problems in education and psychology that have received as much attention as that of the relation of intelligence to college scholarship. During and after World War I the army intelligence tests (Army Alpha and Beta) were widely used in colleges throughout the country. Beginning in 1917 and continuing to the present day remarkable advances have been made in mental test construction and in the uses to which the tests have been put. A conservative estimate of the number of good intelligence tests on the current market is fifty. And there are indications that the number will increase yearly. One of the more usable mental tests for adults (the Wechsler-Bellevue Scale, an individually administered test) was developed and marketed within the past five years.

In 1932 Kinney(7) summarized the literature showing the correlation between intelligence tests and college grades. One of his purposes was to determine whether the relationships calculated in recent years with better made tests were higher than those of an early period. Table One shown below does not reveal such a trend.

**Table I. Correlations Between Intelligence Test Scores and General Scholarship (After Kinney)**

Coefficient of Correlation	Pre-Alpha Test (World War I Army Data)	Up to 1923 Including pre-Alpha	1924-1927	1928-1931	Total (Excluding No. shown in Col. 1)
Over .74	.....	.....	1	1	2
.70 - .74	..... 3	..... 4	.....	.....	4
.70 - .74	..... 3	..... 4	.....	.....	4
.65 - .69	..... 1	..... 7	3	5	15
.60 - .64	.....	..... 9	7	13	29
.55 - .59	.....	..... 5	10	11	26
.50 - .54	..... 2	..... 18	20	21	59
.45 - .49	..... 1	..... 31	20	35	86
.40 - .44	..... 2	..... 29	23	30	82
.35 - .39	.....	..... 21	23	20	64
.30 - .35	..... 2	..... 14	13	15	42
.25 - .29	..... 1	..... 12	7	12	33
.20 - .24	.....	..... 5	4	6	15
.15 - .19	.....	..... 3	1	4	8
.10 - .14	.....	..... 5	.....	1	6
.00 - .09	.....	..... 2	.....	1	3
N	..... 12	..... 165	132	177	474
Md	..... .51	..... .44	.44	.45	.44
Q	..... .35	..... .35	.37	.36	.36
Q3	..... .70	..... .51	.52	.52	.51

It is interesting to note that in the pre-Army Alpha test period the median correlation was .51. During the last period (1928-1931) the median correlation was .45. Apparently the research directed toward the development of more refined intelligence tests has not made these instruments better predictors of college success.

A more recent summary by Segel(10) corroborates Kinney's data. The median correlation found by Segel between intelligence tests and college scholarship was .44. Kinney's was .44 also.

Several institutions, notably the University of Minnesota and the University of Chicago, have studied, over a period of years, the relationship between intelligence and grades. Williamson(13), at the University of Minnesota, has reported a lowering of coefficients of correlation between intelligence tests and scholastic grades from 1924 to 1935. His data concerned students in the College of Science, Literature, and The Arts. His correlations were: 1936, .50; 1938, .50; 1934, .39; 1935, .43. A possible explanation suggested by Williamson was that, during the period under study, Minnesota had developed a more effective personnel program that resulted in better adjustments between academic grades, student aptitudes, and vocational interests.

Reitz(8), at the University of Chicago, noted in his data an increase in the correlations between scholarship (determined by achievement tests) and intelligence tests scores.

Thus at one institution intelligence tests seem to have less and

less predictive value while at another institution (where achievement tests determine course grades) the intelligence tests seem to be increasing in predictive accuracy.

The possibility of long-range forecasting of college scholarship has been reported in only a few studies. Byrns and Henmon(1) using Wisconsin data studied the predictive accuracy of an intelligence test given in grades 3 to 8. They found that the correlation between intelligence quotients derived from these tests with scores on intelligence tests given at college entrance was .81. This is about the size correlation that one may expect to get when two intelligence tests are given at approximately the same time. The correlation between the early test scores and the four-year high school average was .43 and with first semester grades .45.

Thorndike(12) in his pioneering work in long-range prediction obtained similar results in predicting educational success from tests given in the elementary grades.

Thus we find that studies on prediction of college success from intelligence tests often tell conflicting stories. A few general facts, however, are observable. The intelligence test as a predictor of college success has not been improved consistently through the years from 1917 to the present day. Correlations range from practically .0 to .74 with the median around .44. Thus prediction for individual students cannot be regarded as highly accurate, not only because of the low coefficients of correlation, but also because they vary so much from one study to another. The correlations reported indicate that intelligence tests do increase prediction over what would be expected by chance. And because of the educational implication, it is important to note that scores on intelligence tests given at an early age are positively related to later college success.

**High School Grades.** High school grades in general provide a more accurate basis for predicting college scholarship than intelligence tests. Segel(10) summarized a variety of studies, reporting the correlation between college scholarship averages and high school grades. The median coefficient was .55. The range of coefficients was from .29 to .77. The evidence indicates that the high school scholarship is a better single measure for predicting college scholarship than the intelligence test scores.

The accuracy of prediction may be increased further if first semester or first year grades in college are combined with school grades. It is not uncommon to find correlations above .70 when first semester college grades and high school grades are combined.

**Achievement Tests.** General achievement tests are a close second to high school grades as a single basis for predicting college grades. Segel(10) found the median correlation between general achievement tests and college scholarship to be .55. This same correlation was also found between high school and college grades. In the same summary, Segel found the median coefficient for tests of specific aptitudes and subject area to be .37.

**Patterns of High School Subjects.** Since most colleges require certain high school subjects as a basis for admission, the predictive value of these courses are of interest to us. Studies by Douglass 2,3), like results from different universities and colleges, consistently show no relationship between the specific pattern of high school subjects and college grades. From the standpoint of success in college there seems to be little evidence to justify the requirement of certain high school courses for college entrance. However, there are other reasons for requiring specific courses. For instance, high school pupils planning to enter the sciences or engineering should take the amount of mathematics required by the college of their choice.

**Vocational Interest.** The relationship between college grades and vocational interests has been studied with varying degrees of success. Jacobsen(6) in an extensive study at the University of Minnesota found correlations of .30 to .44 between interests and educational abilities. In combination with intelligence test scores the correlations were much higher.

Concerning the relationship between expressed occupational choice and scholastic achievement, Strong (11, p. 518) found that six out of eleven studies indicated that vocational choice is associated with higher grades, one study showed the reverse and five studies found no effect. Strong(p. 529), in summarizing the results of studies on differential interest patterns and success in college, points out the low correlations usually found between interest test scores and college grades. However, in his longitudinal study of dentists he discovered that students with low dentistry interests dropped out of the courses. He states that interest affects the situation in causing a student to elect what interests him and to keep away from courses that do not interest him. It is entirely possible that future studies will show a strong relationship between interests and achievement in curriculums that afford few electives. It is possible that a student, finding himself in courses he dislikes will be an under-achiever until he finds what he does like.

**Personality.** Despite the tremendous amount of research done on personality measurement the results concerning prediction of success are all too meager. Although the instruments currently on the market are far from finished products, some of them seem to correlate with success in college. At times low correlations found between intelligence and scholarship are accounted for by the absence of drive or motivation. Ryan's(9) findings yield some promising results. The correlation between a persistence test and scholarship among a group of sophomores was .48. Since persistence scores and intelligence are not highly correlated, persistence tests are promising predictive instruments. Unfortunately we must wait for test builders to produce reliable and valid measures of persistence and drive.

Even though the coefficients are not high, use of tests of personality represent an effort to bring into the prediction picture some measure of non-intellectual and non-academic traits.

**Combinations of Factors.** It has been commonly found that a combination of several factors yields higher correlations with scholarship than any one single variable. When Edds and McCall(4) combined average high school grades, Otis Group Intelligence, and Cross English test scores, a multiple correlation with scholarship of .81 was obtained. Hartson(5) got a multiple correlation of .75 by combining high school grades, Ohio State Psychological Examination, and the Ohio State Performance Test.

**Prediction of Scholarship in Specific Subjects.** There has been a great deal of interest shown in the prediction of scholarship in specific subjects or groups of subjects. The most frequently used types of measures are general intelligence tests, general achievement tests, and specific aptitude and specific achievement tests.

Segel(10) has made one of the best summaries of data concerning this problem. His summary of correlations is shown in Table II.

**Table II. Correlation Between Scholarship in Specific College Subjects or Subject Groups and Various Predictive Measures (Segel p. 70)**

	General Mental Tests	General Achievement Tests	Tests of Specific Aptitudes or Achievements
Foreign Language .....	.36	.....	.36
French .....	.32	.37	.47
German .....	.36	.....	.....
Latin .....	.41	.....	.....
Spanish .....	.23	.....	.....
English .....	.39	.42	.....
Mathematics .....	.36	.47	.42
Science .....	.45	.....	.....
Exact Science .....	.....	.....	.15
Biology .....	.30	.....	.....
Botany .....	.42	.....	.....
Chemistry .....	.34	.32	.51
Physics .....	.50	.....	.....
Zoology .....	.34	.....	.....
Geology .....	.....	.....	.40
Social Studies .....	.33	.....	.29
Economics .....	.34	.....	.48
History .....	.42	.....	.52
Political Science .....	.27	.....	.52

In the science field the correlations between grades in specific courses and aptitude tests in these fields are highest. General mental tests and general achievement tests show a lower correlation with grades in specific courses. Segel concluded from his study that for predicting scholarship in specific subjects, tests of specific aptitude or achievement are the best. However, the correspondence is not close enough to warrant making many predictions regarding individual students.

**Summary.** Considering the enormous amount of research effort

that has gone into the study of predicting college success, the results are rather discouraging. Intelligence tests yield correlations in the forties; correlations with achievement tests and high school grades are in the fifties. Vocational interest scores and personality scores yield lower correlations. However, the chances are good that progress will be made in the near future on building better instruments in these areas. When better tests are built, our prediction of scholarship will be considerably improved. The evidence is strong in favor of a combination of factors. The most common combination includes intelligence tests, high school grades, and achievement test scores.

## II. *Prediction Studies in Progress at Iowa State College*

The history of research done on the prediction problem at Iowa State College is probably about the same as it is in most similar institutions. For years at the time of entrance, our students have been given an intelligence test, an English test and a mathematics test. These test scores have been investigated for their predictive value. For predicting the success of an individual student, the results have been far from satisfactory. Even a combination of the test results leaves much to be desired. In 1941, a silent reading test was added to the battery administered to new students. This test did not contribute much in the prediction of individual student success.

In 1946 when it became apparent that our campus facilities could not accommodate the number of students who would enroll in September, we obtained the use of a part of Camp Dodge located a few miles north of Des Moines. Last September around 400 freshmen in Engineering and Science went to Camp Dodge.

Since the number of students involved was not as great as it was on the campus proper, we were given an opportunity to plan a more extensive testing program for these students.

In planning the Camp Dodge program, certain facts about students were kept in mind. In general we felt that we knew what a good student looked like and what some of the differences were between good and poor students. From previous entrance test data we knew that a student with a low intelligence test score, low English and mathematics placement test scores and a low high school average had very little chance of success in college. We were aware also of the alarming number of students with high entrance test scores who failed to make the grade. Our clinical experiences with this latter group consistently brought out the fact that as a group, they had a number of vocational guidance problems. Either they were in a curriculum they did not like or they had not made a definite vocational choice. As a group they had more than their share of personal problems and personality adjustment problems.

In selecting the tests for the Camp Dodge students we included the tests usually given our new students: an intelligence test (American Council Psychological Examination, 1945 Edition), an English placement test (USAFI, Correctness and Effectiveness of Express-



sion, College Level), a mathematics placement test (Iowa State College Mathematics Placement Test, Form B), and a silent reading test (Iowa State College Silent Reading Test, Experimental Form).

To this battery we added the Kuder Preference Record. This is a test of interest in nine broad vocational fields. During the past year we have been giving this test to all of our freshmen and seniors in an effort to locate differences of vocational interests among the students in the various curriculums.

Our incomplete data show that there are striking differences among students in some curriculums. We feel that the chances are good that we will locate interest patterns for many curriculums that will be valuable to us in our pre- and after-college counseling.

Another test not used previously was the Minnesota Personality Scale. This test measures morale, social adjustment, family relations, emotionality, and economic conservatism. Scores from this test appear to select the students who are doing unsuccessful work because they have adjustment difficulties.

We have not had time to evaluate our program. We have been using the test scores in our individual counseling of students. We have, merely by inspection of scores, been able to identify a surprisingly large number of potentially good students who are doing poor course work. When all of our data are collected, we will begin an intensive study of the predictive value of this test battery used at Camp Dodge.

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