GRADE TWELVE ACHIEVEMENT AND SCORE ON THE AMERICAN COUNCIL ON EDUCATION PSYCHOLOGICAL EXAMINATION FOR COLLEGE FRESHMEN AS PREDICTORS OF FRESHMAN ACHIEVEMENT AMONG TYPE C STUDENTS IN THE COLLEGE OF ARTS AND SCIENCE UNIVERSITY OF SASKATCHEWAN

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CHAPTER I

THE PROBLEM

Of the perennial problems of education, probably none has proved more fascinating and perplexing than that of prognosis. At all levels of a child's educational career, parents and educators with varying criteria and degrees of expertness endeavor to discern those characteristics predictive of his future success. It is only in very recent times, however, that prognosis has been placed on a relatively objective basis, its methods and techniques evolving from the scientific approach to the solution of educational problems.

With the increase in the number of students enrolling in our high schools has come a corresponding increase in enrolments at the college level. There has arisen the acute problem of guiding students in the selection of courses so as to take account of interest, ability, and as wide a variety of personal factors as possible. Important in such guidance is the early identification of those factors symptomatic of future success. At the college level, we find intelligence tests in very wide use as selectors in various situations some of which are described later in this study. However, as Toops points out, the intelligence tests are "primarily educational administrative devices for dealing with administrative and pedagogical problems of students

rather than the criterion of intelligence of applicants for admission."[1]

College entrance tests, which are made use of widely, vary greatly in nature from one institution to another. Such instruments usually consist of various combinations of standardized special and general achievement tests, intelligence or aptitude tests, and varying senior matriculation standing requirements. Other entrance criteria, less widely used, include recommendations of teachers, interest and personality ratings, health record, and the personal interview. However, there is a definite tendency for admission standards to be defined in terms of specific knowledge, skill, and personal traits, directly measurable at college. Tests of the College Entrance Examination Board, although not extensively used, represent an effort to secure some uniformity in the selection procedures of various universities. Entrance tests, in general, are becoming increasingly analytic with a view to their increased use as guidance devices.

Indeed it is becoming generally recognized that prediction, like guidance, must be reasonably specific, as well as inclusive with respect to its underlying bases. As

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[1] H. A. Toops, "The Status of University Intelligence Tests", Journal of Educational Psychology, Vol. 17, 1926, pp. 23-36, 110-124.

refinements of measurement are made, and as the measured factors become more clearly understood, this goal may be attainable. It seems certain that if major decisions in educational prediction or guidance are made entirely on the basis of a single variable, whether it be a measure of unitary intelligence or general past achievement, such decisions appear likely to result in unwarranted failure and frustration for many counselees.

Although economic considerations alone might make selection inevitable at the University level, the primary purpose of selection and prognosis is that of guidance. These twin elements of a single process are a major step in student self-evaluation and self-direction. As Laycock and Hutcheon indicate, the effect of failure upon personality development is an important consideration underlying the selection process.[2] Modern studies in prognosis at the college level are thus a manifestation of the guidance point of view in higher education, as well as an effort to reduce the pressures of accommodation resulting from an expanding student population.

Statement of the Problem

It was the purpose of this study to investigate grade

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[2] S. R. Laycock and N. B. Hutcheon, "A Preliminary Investigation into the Problem of Measuring Engineering Aptitude", Journal of Educational Psychology, Vol. 30, 1939, p. 280.

twelve achievement and score on the American Council on Education Psychological Examination for College Freshmen as predictors of freshman achievement among type C students in the College of Arts and Science, University of Saskatchewan. Data relate to the students in attendance during the academic years 1947-1948, 1948-1949, and 1949-1950.

Delimitation of the Problem

The study resolved itself logically into the completion of two main operations: (1) the calculation of regression equations for the prediction of college freshman achievement; (2) an analysis of predicted results. More specifically, the steps adopted in the solution of the problem were as follows:

1. The calculation of simple regression equations for the prediction of college freshman achievement using: (a) grade twelve achievement; (b) American Council on Education Psychological Examination scores;
2. The calculation of multiple regression equations for the prediction of college freshman achievement using both grade twelve achievement and American Council on Education Psychological Examination scores;
3. A testing of the efficiency of the regression equations developed in the study through a comparison of representative actual and predicted college honor-point averages.
4. Sex differences apparent in the analysis of the data were

dealt with through the development of separate regression equations for each sex.

Definition of Terms

Grade XII achievement for purposes of this study represents honor-point average attained by fourth year students in Saskatchewan high schools on the basis of either the departmental examinations or the examinations of the various high schools authorized by the department of education to examine students for senior matriculation standing. As Saskatchewan high schools assign marks on a percentage basis, such percentage marks were converted to honor-points on the following basis: 5 points, 80-100; 4 points, 70-79; 3 points, 60-69; 2 points, 50-59; 1 point, below 50 percent.

Curricular subjects for which honor-points were awarded included English (Literature and Composition), Social Studies (History), Mathematics (Algebra, Geometry-Trigonometry), French, Latin, Biology, Chemistry, Physics, and Agricultural Economics. Core subjects in all cases were English, Social Studies, and Mathematics. In addition, at least three options were to be selected, one to be chosen from French, German, and Latin, the second from Biology, Chemistry, and Physics, and the third from the foreign language group or the science group noted above.[3] The term "high school average" as used in this

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[3]University of Saskatchewan Calendar, Session 1947-48, Saskatoon: University of Saskatchewan, 1947, p. 52.

study refers to grade twelve honor-point average.

American Council on Education Psychological Examination scores, hereinafter referred to as A.C.E. scores, were the raw scores secured on the 1946 and 1948 editions of the American Council on Education Psychological Examination for College Freshmen. Equivalence of scores on these editions was secured through use of tables of equivalence provided in the respective test manuals.

Student achievement at the college freshman level represents honor-point average attained in final examinations by first-year students in the College of Arts and Science in the Type "C" group. Honor-points were assigned to percentage marks on the following basis: 5 points, 80-100; 4 points, 70-79; 3 points, 60-69; 2 points, 50-59; 1 point, below 50 percent. Type "C" classes for which honor-points were awarded included a total load of five selected from the following: English; French or German; Political Economy A; two of Biology, Chemistry, Physics, Psychology, Mathematics. The term "college average" as used in this study refers to freshman honor-point average.

Background of the Problem

The usual procedure followed in prognostic studies is to select one or more predictive variables presumably related to the criterion which is generally success or

performance in some particular area of learning. Success on such predictive variables is held to be "symptomatic of an individual's ability to acquire with training some knowledge, skill or set of responses...." -- essentially the process of forecasting on the basis of aptitude.[4]

Probably the earliest of the relatively objective measures of aptitude was the intelligence test. The possibility of its use in selection and counselling seems to have been first suggested by J. McKeen Cattell as a result of the influence of Galton. Sporadic attempts using unsatisfactory testing instruments followed in America. Wissler's efforts at the beginning of the century failed due to the non-intellectual nature of his psychomotor tests originally devised by Wundt. Some years later, efforts were made to use the Binet scale on small groups of university students with unimpressive results.[5] In 1917, with the introduction of the Army Alpha and the Thorndike tests, the possibility of their use in correlation studies became recognized. In the eight years that followed, steady contributions were made to an expanding body of literature that served to lay the foundations of modern prognosis.

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[4]A. B. Crawford and P. S. Burnham, Forecasting College Achievement, London: Yale University Press, 1946, p. 3.

[5]H. J. Eysenck, "Student Selection by Means of Psychological Tests -- A Critical Survey", British Journal of Educational Psychology, Vol. 17, Part 1, February 1947, p. 21.

Most prognostic studies using multiple correlation techniques employ intelligence test results as one of the predictive variables. Various aspects of selection are based on such tests. In a survey of sixty-six colleges, Toops found that nineteen used tests results as a partial basis for admission, forty-nine in determining dismissal for low scholarship, thirty-four in determining probation for low scholarship, thirty-six in determining subject load, forty-two in encouraging extra effort on the part of unmotivated bright students, twenty-three in making recommendations for scholarships, and twenty-five in encouraging able students to undertake graduate work.[6] Despite its various and sometimes largely-ignored limitations, it would appear that the psychological test has won for itself an important place in both the practical and research phases of prognosis.

General achievement at the senior matriculation level has been used for many years as a criterion of fitness for college work. A number of colleges admit students partly on the basis of a minimum senior matriculation average. A survey of studies related to this procedure is presented later in this study to indicate the degree of justification underlying it. The chief logical argument usually offered in support of using high school general achievement as one of the main bases for predicting college success is that presumably

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[6]Toops, op. cit., p. 24.

those personal qualities which make for success at the high school level are similar to those required for success at College.

General Limitations and Assumptions of Prognostic Studies

Before proceeding to a review of the literature, it seems desirable to indicate some of the major limitations and assumptions of prognostic studies. The wise use of the results of such studies is contingent upon a knowledge of possible weaknesses and sources of error.

1. It has been repeatedly demonstrated that only a comparatively small degree of dependence can be placed upon such criteria as marks, regardless of the level at which they are assigned. There are wide differences in the reliability of marks, particularly where tests of a relatively non-objective nature are concerned. There are also differences in the difficulty of tests set by different instructors in the same subject, and perhaps wider differences in difficulty as between various subject matter fields. It is almost certain that some variation exists also in test difficulty as well as in student performance from one year to another. Indeed, Crawford and Burnham point out that for such reasons alone, prognostic tests even with high reliabilities cannot be expected to correlate

higher on the average than .70 with usual course grades.[7] In addition, it should be noted that any test samples only a limited area of knowledge, and the question may be justifiably raised as to whether it is a valid measure of achievement. The results from a certain test given to one group are not always directly comparable with the results on the same test given to another group. This is particularly true in cases where the norms of standardized tests, however representative they may be of the group from which they were obtained, are applied to other groups.

2. In view of the complex nature of both intellectual processes and of personality in general, it is obvious that many factors which play a role in scholastic achievement must, for the present at least, go unmeasured. Before anything approaching really high correlations between criterion and prediction variables is attained, more of such factors will have to be uncovered and measured with probably highly-refined instruments, and, in addition, proper weightings assigned in proportion to their relative importance in determining final results. Interest, persistence, and personal adjustment on entrance to college are only a few of the factors involved.

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[7] Crawford and Burnham, op. cit., p. 65.

Increased success in prognostic work therefore waits upon further research in a number of educational areas. In addition to increased knowledge and better measurement, good subjective judgement is a must in prognosis, if the diverse elements in a particular case are to take on unified form. However, as Garrett points out, for many students the only adequate criterion of fitness is an actual try at college work.[8]

3. There appears to be considerable doubt regarding the factor content of the various psychological tests. One of the difficulties involved is that of determining the extent to which linguistic, quantitative, spatial, and other elements enter into various intellectual tasks. Test makers endeavor to include a wide sampling of such tasks, indicative of a more analytic approach to this problem, but it is obvious that the ultimate solution depends upon a better understanding of the real nature of intelligence.

4. A number of assumptions, limitations and conditions of a statistical nature have an important bearing on the interpretation of prognostic results.

(a) It is assumed that regressions are rectilinear,

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[8]Harley F. Garrett, "A Review and Interpretation of Factors Related to Scholastic Success in Colleges of Arts and Science and Teachers Colleges", Journal of Experimental Education, Vol. 18, No. 2, December 1949, p. 93.

and that the variances in the different arrays of the correlation table are equal. Linearity or non-linearity in correlation data, however, may be demonstrated.

(b) Homogeneity in the groups used with respect to predictive variables and criteria is a condition which is very often not met in prognostic work. As the number of variables is increased, the task of securing homogeneity naturally becomes more difficult. Yet the lumping together of unknowns into a single whole for experimental purposes carries with it the dangers of unwarranted assumption. In addition, the interpretations to be placed upon prognostic results suppose normality in the distribution of scores under investigation.

(c) The coarse grouping of measures for analytical purposes causes a loss of information that may be of value, and, in addition, "exerts a depressing effect on the size of the correlation coefficient."[9] On the other hand, very fine grouping often presupposes an exactness that does not exist in the data.

(d) The use of the percentile rank in many prognostic studies yields a rectangular distribution of the data to which the application of normal probability curve

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[9]Crawford and Burnham, op. cit., p. 129.

properties is mathematically unsound.

(e) Grades made in high school and college are generally assumed to be comparable, although such an assumption is not positively justifiable.[10] The difficulty in establishing comparability is great, however, and it seems that until this problem is solved, correlations between high school grades and college grades are to be interpreted with some reservation.

(f) As selection becomes more effective, and as the inferior students are excluded, the investigator should expect to find a smaller coefficient of correlation between the selector and grades obtained.[11] Obtained coefficients need to be interpreted in the light of this paradox. In some cases a statistical adjustment is made in the coefficient.

(g) The value of multiple correlation procedures is still overlooked in many studies. The results from multiple correlation studies, since they are based on a number of variables, and show higher correlation with the criteria, are almost invariably of more value in prediction than studies based on zero-order

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[10] Garrett, op. cit., p. 93.

[11] Crawford and Burnham, op. cit., p. 63.

correlations. Since so much of the difference found in achievement among individuals remains unexplained and unmeasured, it would seem that at least every improvement in statistical technique should be brought into service.

Summary

Increased enrolments at the high school level have been accompanied by a proportionate increase in enrolments at the college level. This situation, together with the increased pressure on available facilities makes apparent the necessity for student guidance on the basis of as many pertinent variables as possible. In this light, prognostic studies are a manifestation of the guidance point of view in higher education. Their success is dependent upon a better understanding of some of the fundamental problems of educational psychology.

The present study investigates grade twelve achievement and score on the American Council on Education Psychological Examination as predictors of freshman achievement among Type C students in the College of Arts and Science, University of Saskatchewan. The problem involves, in the main, the finding of appropriate regression equations, and the analysis of some results predicted by them. Predictive variables chosen for use in the study were the scores made by freshmen students in the Type "C" group of the College of Arts and Science on the

American Council on Education Psychological Examination and on the final grade twelve examinations in Saskatchewan high schools. Examination results of this group at the end of the college freshman year constituted the criteria.

Prognosis depends on the correct selection and accurate measurement of variables presumably related to success in some field. Earliest of the relatively objective variables used in prediction were results from the intelligence test, the increased refinement of which added a valuable tool to prognostic work. Together with average performance in high school they have been used in a large proportion of the studies.

General limitations and assumptions of prognostic studies should be known to the investigator, since they condition not only the procedure of the study, but the interpretations placed upon results. The future of prognosis rests upon the removal of some of the major limitations.

CHAPTER II

REVIEW OF THE LITERATURE

A large number of studies have been made in the field of prognosis at the college level. Studies described in this chapter involved the calculation of zero-order and multiple correlations using psychological test scores and high school achievement as predictive of college freshman achievement.

Studies Involving Zero-order Correlations Using Psychological Test Scores as Predictive of College Freshman Achievement

A few of the individual studies made of this problem are briefly described. Descriptions of procedures are also given, particularly where they differ somewhat from those usually followed:

The Quaid Study.[1] Quaid used, in addition to other instruments, the American Council Test and the Ohio State University Psychological Examination as predictive variables on one hundred forty freshmen, seventy-five boys and sixty-five girls, at the University of Oklahoma Liberal Arts College. He used honor-point averages to quantify the final

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[1] T. D. D. Quaid, "A Study in the Prediction of College Freshman Marks", Journal of Experimental Education, Vol. 6, March 1938, pp. 350-375.

college freshman marks, and calculated zero-order correlations between them and the psychological test results. The Ohio State University Psychological Examination yielded a correlation of 0.557±0.043, while the American Council Test correlated 0.412±0.047 with the criterion.

The Votaw Study.[2] Votaw compared the results of four hundred twelve freshmen entering Southwest Texas State College in 1941 on freshman honor-point average and on the American Council Psychological Examination score. The correlation which was based on the combined results of these freshmen who entered the various colleges of the University, was calculated to be 0.53. No standard error is given.

The Butsch Study.[3] This study was quite extensive, dealing with more than fifteen hundred students in four separate colleges at Marquette University. The American Council Examination results were correlated with grade-point averages. Correlations were calculated for the year 1934-35, and the subjects from that year were added to the 1935-1936 freshmen group for purposes of further correlation. The 1936-1937 group represented a cumulation of seven hundred fifty cases. Correlations found for the three years indicated were 0.533, 0.535 and 0.525, and were based on three hundred seventy-five, five hundred forty-

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[2]David F. Votaw, "A Comparison of Test Scores of Entering College Freshmen as Instruments for Predicting Subsequent Scholarship", Journal of Educational Research, Vol. 40, November 1946, pp. 215-218.

[3]R. L. C. Butsch, "Improving the Prediction of Academic Success Through Differential Weighting", Journal of Educational Psychology, Vol. 30, September 1939, pp. 401-420.

seven, and seven hundred fifty cases respectively in the College of Liberal Arts.

Minnesota Studies in Predicting Scholastic Achievement (1942).[4] Correlations in these studies which were based on eight hundred twenty-seven students yielded a median of 0.50. American Council on Education Psychological Examination scores and college honor-point ratios were the two variables involved, and results were based on students in the College of Science, Literature and the Arts.

University of Wichita Studies.[5] In this study, four hundred freshmen of the year 1936-1937 were chosen and their results on the Ohio State University Psychological Examination and first semester and freshman year examinations were correlated. First semester marks and psychological test scores correlated 0.466, while freshman year marks and psychological test scores correlated 0.574. The investigator claims that first semester marks are better indices to use, since they include those students who drop out for various reasons before the commencement of the second semester.

Perhaps a better picture of the range and central tendency of various correlation studies involving general college achievement and psychological test scores may be

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[4]Crawford and Burnham, op. cit., p. 129.

[5]Cecil B. Read, "The Prediction of Success in a Municipal University", School and Society, Vol. 48, No. 1232, pp. 187-198.

obtained from a tabular summary of such studies. The information presented in Table I was adapted from a summary study by Garrett.[6] In the original table a median correlation of 0.47 was derived from 94 coefficients exhibiting a range of 0.17 to 0.67. In Table I, only those studies involving the use of the American Council Psychological test and the A.C.E. have been listed.

TABLE I

STUDIES IN THE CORRELATION OF INTELLIGENCE WITH GENERAL SCHOLASTIC SUCCESS IN COLLEGE

Date	Investigator	Institution	r
1928	Harston	Oberlin College (men)	.53
1928	Harston	Oberlin College (women)	.50
1929	Drake	Adelphi Women's College	.51
			.40
			.49
			.40
			.45
1929	Gerberich	Arkansas University	.46
1930	Gerberich	Arkansas University	.58
1931	Gerberich	Arkansas University	.55
1930	Fritz	Pittsburg, Kans., S.T.C.	.53
1931	Douglass	Oregon University (men and women)	.45
		Oregon University (men only)	.42
		Oregon University (women only)	.49
1931	Nelson	Iowa S.T.C.	.67
1935	Fleming	"Colleges"	.50
1935	Fleming	"Colleges" (men only)	.46
1937	Butsch	Marquette University	.53
1939	Dubois	New Mexico University	.44
1944	Weber	Wells College	.45
1945	Smith	Fresno State College	.38

Median = .49

[6] Garrett, op. cit., pp. 107-109.

In Table II are presented the data contained in four summary studies involving a total of 741 coefficients.[7] A median coefficient of 0.45 was obtained.

TABLE II

SUMMARY AVERAGES OF COEFFICIENTS OF CORRELATION REPORTED BETWEEN INTELLIGENCE TESTS AND COLLEGE GRADES
(After Durflinger)

Author	Date	Number of Coefficients	Mean	Median
Harl R. Douglas	1931	160	.44	.45
L. B. Kinney	1932	442	.45	
David Segal	1934	100		.44
Mazie E. Wagner	1934	39		(.40 to .50)

Average figure (whether mean or median) = .45

Generally it may be said that most studies reveal a correlation somewhat under 0.50. A summary of studies which used scores on the A.C.E. and the Ohio State University Psychological Examination as predictive of college achievement revealed an average coefficient of correlation of 0.49 for each test.[8]

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[7]G. W. Durflinger, "Scholastic Prediction in a Teachers College", Journal of Experimental Education, Vol. 11, June 1943, pp. 256-67.

[8]Garrett, op. cit., p. 106.

Studies Involving Zero-order Correlations Using High School Achievement as Predictive of College Freshman Achievement

A few individual studies in this field are briefly described below in order to indicate customary procedures in such studies. The treatment of a summary nature which follows this, although descriptive of studies using various approaches, is believed to give a more reliable indication of the relationship in question.

The Landry Study.[9] Landry studied the correlation between the mean of grade twelve final subject marks and the mean of college freshman marks made by four hundred sixteen males entering three different colleges in New York University. An effort was made to establish comparability of college marks by representing each subject group by the mean sigma value of the group, normality being assumed. A correlation of 0.625 was obtained, with a probable error of 0.023. This particular correlation was the most marked of those worked out, some of which included correlations between the predictive variable and achievement in specific subject matter fields.

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[9]Herbert A Landry, "The Relative Predictive Value of Certain College Entrance Criteria", Journal of Experimental Education, Vol. 5, No. 3, March 1937, pp. 256-260.

The Schmitz Study.[10] This study, based on one hundred eighty-four cases, used the merit-point method of quantifying achievement but carried aggregates rather than averages into the correlation of high school and college marks. Correlation of the two latter variables was found to be 0.644 with a probable error of 0.075. Other variables used were psychological, reading comprehension, and special aptitude scores, all of which yielded considerably lower correlations with college freshman achievement than high school honor-point aggregate. Although the obtained correlation of 0.644 was considered significant, the investigator was doubtful of its value for predictive purposes.

The Berdie-Sutter Study.[11] In this study, completed among freshmen in a college of engineering, high school percentile rank in graduating class was correlated with first year college merit-point ratio. On the basis of results from three hundred seventy-two students, a correlation of 0.50 was obtained. In correlations using the same two variables, with groups of sixty-five and one hundred eighty-nine students who had registered in slightly different subject patterns, correlations of 0.63 and 0.50 respectively, were obtained. These

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[10] S. B. Schmitz, "Predicting Success in College: A Study of Various Criteria", Journal of Educational Psychology, Vol. 28, September 1937, pp. 465-473.

[11] Ralph F. Berdie and Nancy A. Sutter, "Predicting Success of Engineering Students", Journal of Educational Psychology, Vol. 41, No. 3, March, 1950, pp. 184-190.

correlations, though somewhat lower than those generally found in such studies, were considerably higher than the correlations found between college merit-point ratio and such other predictive variables as the Paper Form Board Test, Co-operative Mathematics Test, and the General Educational Development Test. Limitations attending the use of the percentile rank in correlation procedures should be noted in considering results of this study.

The Hertel-DiVesta Study.[12] Results in this study were based on a total of three hundred twenty-four freshmen who were divided into three groups according to the particular options chosen in a first year agricultural course. Differences among the groups existed mainly in the number of first-year science classes being studied. Correlations between first term college average and high school average in the three groups were 0.538, 0.398 and 0.605, while the correlation for the combined group was 0.525. These correlations were much higher than those obtained when college freshman average was correlated with test results from the Ohio State Psychological Examination or results from several specific achievement tests.

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[12] J. P. Hertel and Frances J. DiVesta, "An Evaluation of Five Factors For Predicting the Success of Students Entering the New York State College of Agriculture", Educational and Psychological Measurement, Vol. 8, 1948, pp. 389-395.

The Drake-Henmon Study.[13] Completed in a college of liberal arts, this study utilized the college grade-point averages and the high school ranks of six hundred eighteen freshmen at the University of Wisconsin. A correlation coefficient of 0.60 was obtained, which the investigator claimed should make possible prediction of college grade-point average with an efficiency at least thirteen percent better than chance. Results from two mental ability tests, the American Council and the Henmon-Nelson correlated 0.58 and 0.48 respectively with college grade-point average.

Generally, high school achievement appears to be a more valuable indicator of probable college achievement than any other single variable yet used in prognostic studies. Individual studies and their summaries bear out this statement. Garrett's summary of thirty-two coefficients range from 0.29 to 0.83 with a median of 0.56.[14] Part of the summary information contained in this study is presented in Table III.

Douglass' summary of sixty-seven studies made before 1931, and Symonds' summary average for twenty-eight studies made before 1929, yielded correlations of 0.54 and 0.47

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[13]Lewis E. Drake and V. A. C. Henmon, "The Prediction of Scholarship in the College of Letters and Science at the University of Wisconsin", School and Society, Vol. 45, No. 1154, February 1937, pp. 191-194.

[14]Garrett, op. cit., p. 94.

TABLE III

STUDIES IN THE CORRELATION OF AVERAGE HIGH SCHOOL SCHOLARSHIP WITH COLLEGE AVERAGE

Date	Investigator	Institution	N	Time	r
1921	Scates	Chicago Univ.	1707	1 yr.	.61
1921	Cocking & Holy	Ohio Univ.	266	1 yr.	.55
1922	Beatley	Harvard Univ.	423	1 yr.	.56
1922	Henderson	Columbia Univ.			.45
1922	Henderson	Carnegie Univ.			.29
1922	Henderson	Ohio Univ.			.38
1923	Anderson & Spencer	Yale Univ.	402	4 yrs.	.44
1922	Symonds	Hawaii Univ.		1 sem.	.55
1923	Somers	Colorado Univ.	212	1 sem.	.83
1924	Proctor	Stanford Univ.	473	1 qutr.	.45
1924	Odell	Illinois Univ.	2000	1 yr.	.55
1924	Odell	Illinois Univ.	2000	4 yrs.	.54
1927	Douglass	Oregon Univ.	385	5 sem.	.56
1927	Jones	Indiana S.T.C.	325	1 sem.	.56
1927	Jones	Indiana S.T.C.	325	1 yr.	.60
1928	Pierson	"College"	50		.52
1928	Hartson	Oberlin College			.55
1928	Hartson	Oberlin College	women	1 sem.	.46
1929	Whitney	Colorado S.T.C.	899	2 yrs.	.50
1930	Prosser	Iowa Univ.	280	1 sem.	.51
1931	Crawford & Burnham	Yale Univ.	3277	1 yr.	.57
1931	Patterson	Minnesota Univ.	309		.31
1931	Patterson	Minnesota Univ.	229		.45
1932	Hartson	Oberlin College (w)	150	1 sem.	.47
1932	Hartson	Oberlin College (m)	120	1 sem.	.45
1934	Finch & Nemzek	Minnesota Univ.	90	1 yr.	.79
1935	Byrns & Henmon	Minnesota Univ.	250	1 sem.	.72
1936	Read	Wichita Univ.	400	1 sem.	.63
1936	Read	Wichita Univ.	400	2 sem.	.64
1936	Read	Wichita Univ.	400	1 yr.	.67
1935	Garrett	52 colleges	200	1 sem.	.67

Number of coefficients = 32
Range = .29 to .83
Median = .56

respectively.[15] It might be noted that on the basis of available evidence there is little difference in the efficiency with which average high school scholarship predicts college freshman achievement and later college achievement.

The percentile rank, despite its limitations, is a very frequently-used means of expressing high school achievement for prognostic purposes. In one summary study involving eighteen separate investigations employing percentile rank in high school as a predictive variable, a median correlation of 0.575 was noted, while in a similar summary study involving twenty-nine separate investigations, some of which employed high school rank, a median coefficient of 0.548 was obtained.[16] (Data from the latter study will be found in Appendix A.)

Studies Involving Two-Variable Multiple Correlations Emphasizing Psychological Test Scores and High School Achievement as Predictive of College Freshman Achievement

Because of their greater predictive value, multiple correlations are finding increased use in prognostic studies. Many different variables are employed; combinations of scores from such instruments as aptitude tests, intelligence tests, general and specific achievement tests, and high school average or percentile rank are among the most common in this field. Studies employing high school achievement indices and psy-

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[15] Ibid., p. 95.

[16] Ibid., p. 96.

chological test scores as predictors are given special attention in this section.

Minnesota Studies in Predicting Scholastic Achievement (1942).[17] These investigations were carried out in the College of Science, Literature and the Arts at Minnesota University, and involved eight hundred twenty-seven students. A.C.E. scores and high school percentile rank, although yielding zero-order correlations with the criterion in the neighborhood of 0.50, yielded a multiple correlation of 0.63. Results on the Ohio State Psychological Examination and high school percentile ranks from the same group gave a multiple correlation of 0.61 with the college honor-point ratios.

The Laycock-Hutcheon Study.[18] Findings in this study are based on data relating to one hundred forty-four freshmen entering the College of Engineering, University of Saskatchewan, in the Fall of 1937. Data included average marks in the grade twelve final examinations and in the final examinations of the College of Engineering, and in addition, results on six other tests, one of which was the 1937 edition of the A.C.E. Zero-order correlations between grade twelve average and college freshman average, and between the psychological test scores

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[17] Crawford and Burnham, op. cit., p. 129.

[18] S. R. Laycock and N. B. Hutcheon, "A Preliminary Investigation into the Problem of Measuring Engineering Aptitude", Journal of Educational Psychology, Vol. 30, April 1939, pp. 280-288.

and college freshman average were 0.61 and 0.34 respectively, while the multiple correlation of grade twelve average marks and psychological test scores with college average marks was 0.62. In this study, psychological test results appear to add but little to the predictive value of grade twelve results. This is to be expected in view of the low zero-order correlation found between the former and the criterion.

The Drake-Henmon Study.[19] Drake and Henmon in their multiple correlation study used the results of six hundred eighteen freshmen in the College of Liberal Arts at the University of Wisconsin in 1933. College marks were reduced to grade point averages, and high school achievement was represented by ranks. The multiple correlation of centile scores on the American Council psychological test and achievement centile rank in high school graduating class with college grade point average was found to be 0.69. When Henmon-Nelson mental ability test results were substituted for the American Council test results, the correlation dropped to 0.66. Standard errors of estimate were 0.62 and 0.65 respectively.

The Quaid Study.[20] Quaid studied one hundred forty freshmen entering Arts and Science options at Phillips

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[19]Drake and Henmon, op. cit., pp. 191-194.

[20]T. D. D. Quaid, "A Study in the Prediction of College Freshman Marks", Journal of Experimental Education, Vol. 6, March 1938, pp. 350-375.

University with respect to scores on the Ohio State University Psychological Examination, the American Council Psychological Examination, and grade twelve honor-point average. These predictive variables were correlated with first semester college honor-point average, the calculation of which was based on a five-category classification: Division A - five points, Division B - four points, Division C - three points, Division D - two points, Below Division D - one point. The multiple correlation of first semester college marks with American Council Test scores and high school honor-point average was 0.590 with a probable error of $\pm$0.445; the multiple correlation of first semester college average with Ohio State University Psychological Examination scores and high school average was 0.605 with a probable error of $\pm$0.436.

The value of multiple correlation techniques has been conclusively demonstrated. As noted previously, the median zero-order coefficient of correlation between intelligence and college success in a large number of studies was found to be 0.47, while for the high school grade average the median was 0.56. One investigator, however, in a summary study of twenty combinations of these two factors found a median multiple correlation coefficient of 0.62.[21]

Two-variable multiple correlations with college success involving the use of psychological tests and high school marks

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[21]Garrett, op. cit., p. 120.

are presented in Table IV.[22]

TABLE IV

TWO-VARIABLE MULTIPLE CORRELATIONS USING PSYCHOLOGICAL TEST SCORES AND HIGH SCHOOL MARKS AS PREDICTORS OF COLLEGE SUCCESS

Variables	Zero Order Coefficient	R	Investigator
1. Battery: Army Alpha Haggerty Delta, Pressey Class., Terman Group, & Miller M.A.T.	.48		
High School honor point average	.79	.79	Finch & Nemzek
2. Otis Group	.42		
High School marks	.79	.79	Edds&McCall
3. Ohio State Psy. Ed.	.61		
H.S. Average	.67	.69	Garrett
4. High School average	.63		
& Ohio Univ. Psy. Test	.42	.64	Read
5. American Council	.60		
& H.S. marks (men)	.40	.63	May
6. American Council	.46		Williamson&
& H.S. percentile	.53	.63	Freeman
7. A.C.E.	.46		Williamson&
& H.S. Average (women)	.58	.63	Freeman
8. High School Average	.53		Williamson&
& O.S.U. (men)	.53	.61	Freeman
9. High School Average	.58		Williamson&
& O.S.U. (women)	.54	.61	Freeman
10. Thorndike	.41		
& H.S. marks (men & women)	.52	.58	Proctor
11. High School Marks	.55		
& Otis Self-Admin.	.58	.58	Odell
12. American Council	.496		Douglass &
& H.S. percentile	.425	.57	Lovegren
13. Thorndike	.37		Bolenbaugh&
& H.S. marks	.49	.54	Proctor
14. Thorndike	.45		Bolenbaugh&
& H.S. marks	.28	.48	Proctor

[22] Ibid., p. 121.

It should be noted that the addition of a third or a fourth variable to the predictive combination usually adds so little to the efficiency of prediction that it does not justify the increased computation involved. The highest multiple correlation coefficients noted in the literature were usually yielded by a combination of intelligence and achievement tests, and high school average, and generally range from 0.60 to 0.70.

Summary

A review of the literature reveals the superiority of high school average as a single predictor of college success, the median correlation coefficient being about 0.56. Intelligence test results yield a median coefficient of correlation of about 0.47, while a combination of intelligence test scores and high school average yields a multiple coefficient in the neighborhood of 0.62.

In general, high school average, general achievement test scores, intelligence test scores and general and special aptitude test scores rank in the order given as predictors of college success.

CHAPTER III

THE PROCEDURE OF THE STUDY

Instruments and Sources of Data

The American Council on Education Psychological Examination for College Freshmen. This single-form test developed by L. L. Thurstone and T. G. Thurstone has been available since 1924, although there were earlier editions entitled, "Psychological Examination for High School Graduates and College Freshmen". Although a new form has been issued annually, the later forms of the test contain only slight revisions. However the scores on the 1946 and 1948 forms concerned in this investigation are not directly comparable.

The test endeavors "to appraise what has been called scholastic aptitude or general intelligence, with special reference to the requirements of most college curricula".[1] There are six main subtests, three so-called quantitative tests consisting of arithmetic problems, number series, and figure analogies, and three linguistic tests consisting of the familiar same-opposite, completion, and verbal analogies items, yielding a total of two hundred items.

It is administered as a group test under standard conditions and requires about eighty minutes, including time for

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[1] American Council on Education Psychological Examination for College Freshmen, Manual of Instructions, New York: Educational Testing Service, Cooperative Test Division, 1948, p. 2.

initial instructions and practise exercises which precede each subtest. All subtests are timed and all answers are indicated by blackening in the appropriate lettered space on a separate answer sheet.

Raw scores are obtained by allotting one point to each correctly answered item. Provision is made for recording the raw score on the "Q" and "L" sections of the test in addition to their total. The norms include tables of percentile ranks for these three sets of scores and for the sexes, although the authors advise that test norms be tabulated in terms of either percentile ranks or standard scores for a specific group.

Norms are based on scores from a large number and variety of colleges on this continent, including four year colleges, teachers colleges, junior colleges and other schools. The 1948 edition norms are based on a summary of scores reported by 248 colleges for 43,152 students, while the 1947 edition norms are based on scores reported by 293 colleges for 65,276 students. Reliability of the gross scores is reported to be in the neighborhood of 0.95. Practically no information is supplied by the authors concerning validity, although it has been found that the correlation between scholarship and test scores on the 1940 edition have averaged around 0.50 for a large number of colleges.[2] In his summary study of A.C.E. -

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[2]Crawford and Burnham, op. cit., p. 91.

college achievement correlations, Garrett reports a median coefficient of 0.49.[3]

Individual and comparative studies yield somewhat conflicting results. Quaid, in a study to which reference has been made, found an American Council Test-college achievement correlation of 0.408, while the Ohio State University Psychological Examination correlated 0.522 with the same criterion.[4] He concludes that neither test is superior for all levels of ability and for both sexes, but that the former correlates consistently higher with college achievement of males in the upper part of the curve. Lanigan investigated the value of the A.C.E. and the Otis Test of Mental Ability, and found that although the former did a better job of discriminating between low and high achievement groups, its efficiency was not such as to justify its use as a single instrument for prognostic purposes.[5] Only two significant correlations were found between this test and grade averages in differential prediction. Laycock and Hutcheon found a correlation of only 0.34 between A.C.E. scores and freshman engineering final examinations.[6]

Critics of the test find a number of limitations that

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[3]Garrett, op. cit., p. 106.

[4]Quaid, op. cit., p. 140.

[5]M. A. Lanigan, op. cit., p. 293.

[6]Laycock and Hutcheon, op. cit., p. 285.

should be noted. Guilford and Commins note the extensiveness of the norms and their nation-wide coverage but believe that the smaller institution is overweighted in the norms.[7] Crawford and Burnham believe that the sampling is not representative, and that as a result the correlation between test scores and various achievement criteria may be expected to differ widely from one institution to another, depending upon the range of ability among such variant student groups.[8]

With respect to test content, Guilford makes the following criticism:[9]

> The tests in the 'linguistic' part of the examination seem to be most heavily saturated with verbal-factor variance. The 'quantitative' part is a conglomerate factorially. (It)... probably measures three kinds of reasoning as well as other factors to a small degree. ... It should be unnecessary to use six parts in order to derive two part scores. A vocabulary test would suffice for the linguistic or verbal score. The number series test could be dispensed with in the 'quantitative' part, since it probably adds nothing unique in the way of factors.

Criticism has also been made of the fact that greater weight is attached to the linguistic than to the quantitative score, although it has been claimed that most college courses call for greater linguistic than quantitative ability.[10] The

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[7] O. K. Buros, The Third Mental Measurements Yearbook, New Brunswick: Rutgers University Press, 1949. See reviews by W. D. Commins and J. P. Guilford, pp. 297-298.

[8] Crawford and Burnham, op. cit., p. 94.

[9] Buros, op. cit., p. 297.

[10] O. K. Buros, The 1940 Mental Measurement Yearbook, Arlington: The Gryphon Press, 1945. See review by Jack W. Dunlap, p. 200.

authors' claim that the Q and L scores would have some value for counseling is disputed by MacPhail who found that Q scores correlated more highly with many verbal problems than did the L scores.[11] A number of reviewers have expressed similar doubts regarding the wisdom of the linguistic - quantitative division from the standpoint of utility. Commins has suggested that attention should rather be focused on the items:[12]

> This might be in the direction of the 'mental functions' that are supposedly tested by the items constituting each subtest. The psychologist would like the material to be homogeneous in this respect and is not always satisfied with the exclusive use of a 'factor analysis' approach and the disregarding of some kind of "qualitative" analysis. Thus some items in the completion test of the present edition seem to plumb one's familiarity with the relatively uncommon words, as 'gill' and 'gobbler', while other items seem aimed more at an understanding of the object whose name is sought.

Despite these criticisms, the test yields comparatively good results. In a summary of ninety-four studies, Garrett found the A.C.E. and the Ohio State University Psychological Examination each correlated 0.49 with college achievement, but that the former was by far the most popular test.[13] Results in general indicate that A.C.E. scores yield consistently higher correlations with the criteria than do those

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[11]A. H. MacPhail, "Q and L Scores on the A.C.E. Psychological Examination", School and Society, Vol. 56, No. 1447, September 1942.

[12]Buros, The Third Mental Measurements Yearbook Op. cit., p. 297.

[13]Garrett, op. cit., p. 106.

of other tests.

Grade twelve marks. Information concerning grade twelve marks was obtained from the files of the College of Arts and Science. Only those students who had obtained standing in at least eight but not more than nine subjects of the course were included in the study. Standing was based on the examinations set by the Saskatchewan Department of Education, or by Saskatchewan schools authorized to recommend students for such standing.

The departmental marks, which are assigned on a percentage basis, were converted to honor-point averages which represent average standing in the required and optional subjects of the grade twelve course previously described. The use of the honor-point method of converting percentage marks, the basis of which has already been described, is frequent in prognostic studies. It is doubtful whether the reliability of marks at any level justifies the fine discrimination implied in the use of averaged percentages.

College freshman marks. Freshman marks in the study are based on final standing in five classes of the first year type "C" group in the College of Arts and Science. The marks, representing standing in the course patterns previously described, were converted to honor-point averages on the same basis as were the grade twelve marks.

The Type "C", or natural sciences group was chosen for

study because of the fact that achievement in at least some of the freshman classes in any course pattern is measured largely by objective tests. In view of this, it was assumed that the final examination results, on the whole, would possess greater reliability than comparable results in other types of courses in the College of Arts and Science.

The groups. Subjects for the study were chosen from the 1947-1948 and 1948-1949 Type C freshman enrolments in the College of Arts and Science. One hundred four men and twenty-nine women in the 1947-1948 session, and eighty-nine men and forty-four women in the 1948-1949 session satisfied the conditions for tentative admission to the study. There were four groups, comprising two hundred sixty-six subjects which formed the basis for the initial analysis of the data. Results of this initial analysis necessitated the exclusion from the study of the 1948-1949 male group. The 1949-1950 group which was used to test the regression equations consisted of fifty-one men and twenty-four women.

Analysis of the Data

The two main functions of the analysis of the data were the selection of the subjects, and the determination and testing of simple and multiple regression equations based on data relating to these subjects. The steps involved in these two operations are listed below.

Selection of the Subjects.

1. The analyses of variance conducted on the high school averages, A.C.E. scores, and college averages revealed that there were one or more significant differences between the means of high school averages, and between the means of A.C.E. scores of the four experimental groups.
2. The t tests conducted on the means of high school averages of the 1947-1948 and 1948-1949 men, and on the means of high school averages of the 1947-1948 and 1948-1949 women revealed no significant differences. However, the difference between the means of the 1947-1949 men's and women's high school averages was found to be significant.
3. The t tests conducted on the means of A.C.E. scores of 1947-1948 and 1948-1949 men, and on the means of A.C.E. scores of the 1947-1948 and 1948-1949 women revealed a significant difference in the case of the two male groups only.
4. The t test conducted on the means of college averages of the 1947-1949 men and women indicated that there was no significant difference.
5. Results of this preliminary analysis necessitated the exclusion of the 1948-1949 men from the study.
6. The finding of a significant difference between the means of high school averages of 1947-1948 men and the 1947-1949 women necessitated the development of separate regression

equations for the sexes.

7. Tests for normality conducted on the high school averages, A.C.E. scores, and college averages of the remaining groups, the 1947-1948 men and 1947-1949 women, revealed that these data were normally distributed.

8. F tests conducted on the high school averages, A.C.E. scores and college averages of the 1947-1948 and 1948-1949 women indicated that there were no significant differences in variability in these two groups.

Calculation of regression equations.

1. Zero order correlations required in the construction of regression equations were found between the high school averages and college averages, between A.C.E. scores and college averages, and between high school averages and A.C.E. scores for each of the two main groups. The t tests indicated that the correlations between high school averages and A.C.E. scores of both groups were not significant, while the remaining correlations were significant.

2. Multiple correlation coefficients were also determined and tested for significance.

3. Simple and multiple regression equations using high school averages and A.C.E. scores as predictive of college averages were calculated for both sex groups and tested on data relating to the 1949-1950 subjects. Confidence intervals were set up for the purpose of indicating the

deviation of obtained averages from those predicted employing the regression equations.

Summary

Data for this study included the scores of students on the American Council on Education Psychological Examination for College Freshmen, on the final grade twelve examinations of the Saskatchewan Department of Education or of Saskatchewan schools authorized to examine students, and on certain Type C classes in the College of Arts and Science.

A survey of the literature on prognosis indicated that score on the A.C.E. finds frequent use as a predictive variable.

Although reviewers and investigators make various criticisms of the construction and content of the A.C.E., it is probably as good a test as any in its field. The correlations with college success found in various investigations bear out this statement.

Grade twelve marks which are assigned on a percentage basis were converted to honor-point averages, representing standing in at least eight but not more than nine subjects of the Saskatchewan grade twelve course. The chief argument underlying the use of honor-point averages is the lack of reliability in marking.

College freshman marks, which were also converted to

honor-point averages, represent standing in the Type C course patterns already described. It was considered that marks in the Type C classes in general, would possess greater reliability than comparable marks in other types of course patterns in the College of Arts and Science.

Subjects involved in the preliminary analysis included one hundred four men and twenty-nine women in the 1947-1948 session, eighty-nine men and forty-four women in the 1948-1949 session, and fifty-one men and twenty-four women in the 1949-1950 session. Results of the preliminary analysis, however, necessitated exclusion of the 1948-1949 male group. Data relating to students of the 1949-1950 session were used to test the regression equations.

The finding of a significant difference between the means of high school averages of the 1947-1948 men and the 1947-1949 women made it necessary to develop separate regression equations for these two groups.

Tests for normality conducted on the high school averages, A.C.E. scores, and college averages of the two main groups indicated the data were normally distributed.

Tests for the significance of differences in variability of these groups with respect to the three variables indicated that there were no significant differences.

Zero-order intercorrelations were calculated between scores on the three variables, and tested for significance.

These coefficients were then used in the determination of simple and multiple regression equations which were tested on data relating to subjects of the 1949-1950 session. Confidence intervals were set up in order to indicate the deviation of obtained from predicted averages.

CHAPTER IV

SELECTION OF THE SUBJECTS

The purpose of the preliminary analysis of the data was to select final experimental groups through testing the significance of differences in central tendency and variability of the four initial groups. In addition the experimental groups were tested for the normality of distribution of their scores on the three variables.

In Table V are presented the various preliminary statistics derived from an analysis of the data.

TABLE V

DESCRIPTIVE STATISTICS DERIVED FROM DATA RELATING TO THE 1947-48, 1948-49, 1947-49, and 1949-50 MEN'S AND WOMEN'S HIGH SCHOOL AVERAGES, COLLEGE AVERAGES AND A.C.E. SCORES[1]

Group	H.S. Average		College Average		A.C.E. Score	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Men						
1947-48	4.0401	0.6100	2.9057	0.9498	119.2884	19.8760
1948-49	3.9565				109.3146	
1947-49	4.0016	0.6393	2.8165	1.0066		
1949-50	4.0994	0.6967	3.0549	0.9893	125.0784	19.4523
Women						
1947-48	4.3855	0.5051	2.9724	1.0143	118.6551	20.6928
1948-49	4.3356	0.5917	3.0057	0.9347	115.4318	17.7128
1947-49	4.3554	0.5647	2.9924	0.9696	116.7123	19.1868
1949-50	4.3262	0.6726	3.0750	1.0890	126.5416	17.9447

[1]Statistics in this table are expressed in honor-point units.

Tests for the Presence of Significant Mean Differences -- Analyses of Variance

The method of analysis used here is one which permits the simultaneous testing of a number of groups for the significance of differences between means. A brief description of the results is given for the four groups involved in this study representing their high school averages, their college averages, and their A.C.E. scores. The one percent level of significance has been used in testing hypotheses.

Analysis of variance of high school averages. Data presented in this section relates to 1947-48 men, 1948-49 men, 1947-48 women, and 1948-49 women.

Results of this analysis are presented in Table VI. With an observed F value of 6.03, tables of F were entered with 3 degrees of freedom for the larger variance and 262 degrees of freedom for the smaller variance. Since the observed F exceeded 3.86, the value of F at the one percent level, the null hypothesis that there were no significant differences between the means of the four groups was rejected.

TABLE VI

ANALYSIS OF VARIANCE OF THE HIGH SCHOOL AVERAGES OF 1947-48 AND 1948-49 MEN, AND 1947-48 AND 1948-49 WOMEN

Analysis of Variance	Sum of Squares	d.f.	Mean Square
Between the means of groups	7.0118	3	2.3372
Within groups	101.4062	262	0.3870
Total sum of squares	108.4180	265	

$F_o = 6.03$ $F_{0.01} = 3.86$

Analysis of variance of college averages. The procedure followed in testing for the significance of mean differences existing between the four groups with regard to college average is identical to that used on high school averages as described above. Data relating to this test are presented in Table VII. Since the observed F value of 1.15 is exceeded by the F value at the one percent level, the null hypothesis that there were no significant differences between any of the four means was sustained.

Analysis of variance of A.C.E. scores. A procedure similar to that used for analyzing high school and college averages was employed with A.C.E. scores. The results have been briefly presented in Table VIII. It will be noted that the observed F of 4.47 exceeds the F at the one percent level.

The null hypothesis that there were no significant differences between the A.C.E. means was therefore rejected.

TABLE VII

ANALYSIS OF VARIANCE OF THE COLLEGE AVERAGES OF 1947-48 AND 1948-49 MEN, AND 1947-48 AND 1948-49 WOMEN

Analysis of Variance	Sum of Squares	d.f.	Mean Square
Between the means of groups	3.4517	3	1.1505
Within groups	261.9522	262	0.9998
Total sum of squares	265.4039	265	
$F_0 = 1.15$		$F_{0.01} = 3.86$	

TABLE VIII

ANALYSIS OF VARIANCE OF THE A.C.E. SCORES OF 1947-48 AND 1948-49 MEN, AND 1947-48 AND 1948-49 WOMEN

Analysis of Variance	Sum of Squares	d.f.	Mean Square
Between the means of groups	5169.2320	3	1723.0773
Within groups	101027.8846	262	385.6026
Total sum of squares	106197.1166	265	
$F_0 = 4.47$		$F_{0.01} = 3.86$	

It should be noted that the F test as employed in the analysis of variance indicates only whether there are one or more significant differences between the means concerned in the analysis; it does not indicate which particular differences are significant. The significance of the difference between any two given means is determined by the t test. The next section is concerned with a description of such tests conducted on both the high school averages and the A.C.E. scores.

The Determination of Significant Mean Differences

High school averages. The high school averages of the two groups of each sex were first tested for the significance of mean differences using the t ratio:

$$t_o = \frac{\text{absolute difference between two means}}{\text{SE of the difference}} \qquad (4.1)$$

Table IX contains a summary of the results of this test conducted on the means of the 1947-48 and 1948-49 men's high school averages.

TABLE IX

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF HIGH SCHOOL AVERAGES OF THE 1947-48 AND 1948-49 MEN

Mean of 1947-48 men	Mean of 1948-49 men	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
4.0401	3.9565	191	0.0836	0.0926	0.90	2.60	Sustained

Since the t at the one percent level of significance exceeds the observed t, the null hypothesis that there was no significant difference between these two means was sustained.

Data relating to the test of significance conducted on the means of the high school averages of the 1947-48 and 1948-49 group of women are presented in Table X. The t at the one percent level of significance exceeds the observed t, and the null hypothesis was therefore sustained.

TABLE X

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF HIGH SCHOOL AVERAGES OF THE 1947-48 AND 1948-49 WOMEN

Mean of 1947-48 women	Mean of 1948-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
4.3855	4.3356	71	0.0499	0.1356	0.37	2.65	Sustained

A similar test of significance was then made on the difference between the means of high school averages of the 1947-49 men and the 1947-49 women. Table XI contains a summary of the data relating to the test conducted on these two groups.

A comparison of the observed t and the t at the one percent level of significance indicates that the null hypothesis must be considered refuted. The two sex groups therefore differ significantly with respect to the means of their high

school averages.

TABLE XI

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF HIGH SCHOOL AVERAGES OF THE 1947-49 MEN AND THE 1947-49 WOMEN

Mean of 1947-49 men	Mean of 1947-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
4.0016	4.3554	264	0.3538	0.0853	4.14	2.59	Refuted

College averages. The analysis of variance conducted on the college averages of the four groups indicated there were no significant mean differences between any of the groups. Groups of similar sex were therefore combined. Although a mean difference for the two resulting groups would seem unlikely, a t test was run on these groups. Table XII provides a summary of the results.

TABLE XII

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF COLLEGE AVERAGES OF THE 1947-49 MEN AND 1947-49 WOMEN

Mean of 1947-49 men	Mean of 1947-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
2.8165	2.9924	264	0.1759	0.1373	1.28	2.59	Sustained

Since the null hypothesis was sustained, it was con-

cluded that no sex difference existed with respect to mean college average.

A.C.E. scores. As in the case of high school averages, the t test of significance was first run on the A.C.E. means of similar sex groups. A description of the test results conducted on the means of the two male groups is found in Table XIII. It will be noted that since the observed t is greater than t at the 0.01 level of significance, the null hypothesis that no significant difference existed between these two means was considered refuted.

TABLE XIII

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF A.C.E. SCORES OF THE 1947-48 AND 1948-49 MEN

Mean of 1947-48 men	Mean of 1948-49 men	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
119.2884	109.3146	191	9.9738	2.8576	3.49	2.60	Refuted

In Table XIV are shown the results of the corresponding test carried out on the means of the women's A.C.E. scores.

The size of the observed t and of t at the one percent level indicated that the null hypothesis was sustained.

TABLE XIV

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF A.C.E. SCORES OF THE 1947-48 AND 1948-49 WOMEN

Mean of 1947-48 women	Mean of 1948-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
118.6551	115.4318	71	3.2233	4.5969	0.70	2.65	Sustained

Some Implications of the Analysis for Procedure

1. The finding of a significant difference between the means of the 1947-49 men's and women's high school averages indicated the necessity for separate treatment of the sexes, that is, the necessity for the development of separate regression equations.

2. The finding of a significant difference between the means of A.C.E. scores of the 1947-48 and 1948-49 men made the combination of the male groups impossible from a statistical viewpoint. It was therefore decided to use the data pertaining to the 1947-48 men only in the remainder of the study. This particular group was retained because it contained a larger number of subjects.

In order to determine whether significant mean differences persisted between variables of the single male group retained and the combined female groups, and for what light it might throw on sex differences, t tests were run on the means of high school averages and A.C.E. scores.

In table XV the results of the test on high school averages are summarized. It will be noted that the mean difference in high school achievement of the sex groups remains significant.

TABLE XV

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF HIGH SCHOOL AVERAGES OF THE 1947-48 MEN AND 1947-49 WOMEN

Mean of 1947-48 men	Mean of 1947-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
4.0401	4.3554	175	0.3153	0.0894	3.53	2.60	Refuted

The t test on the A.C.E. scores of the corresponding groups is described in Table XVI. Since the observed t is exceeded by t at the one percent level of significance, the null hypothesis that no significant difference existed between the means of these two sex groups on A.C.E. scores was sustained.

TABLE XVI

TEST OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN MEANS OF A.C.E. SCORES OF THE 1947-48 MEN AND 1947-49 WOMEN

Mean of 1947-48 men	Mean of 1947-49 women	d.f.	$\bar{d}$	SE	t_o	$t_{.01}$	Null Hypothesis
119.2884	116.7123	175	2.5761	2.9892	0.86	2.60	Sustained

Tests for Normality

Since the assumption of normality underlies a number of the tests used in the analysis of the data, as well as the interpretations to be placed upon final results, tests for the normality of distribution of scores on the study variables have been made using the method of areas. The observed frequencies were tested against the frequencies expected on the assumption of a normal distribution using the chi-square test of goodness of fit.

Normality Tests on Data Relating to 1947-48 Men

High school averages, college averages, and A.C.E. scores. Results of the tests for normality conducted on these scores are summarized in Table XVII. In all cases the observed chi-square values were exceeded by the chi-square values at the one percent level. The null hypotheses were sustained, and it was concluded that all scores were normally distributed.

TABLE XVII

TESTS OF THE GOODNESS OF FIT OF THE DISTRIBUTIONS OF 1947-48 MEN'S HIGH SCHOOL AVERAGES, COLLEGE AVERAGES, AND A.C.E. SCORES TO NORMAL DISTRIBUTIONS

Variable	d.f.	χ^2_o	$\chi^2_{o.01}$	Hypothesis
High school averages	8	12.376	20.090	Sustained
Col. Ave.	10	10.932	23.209	Sustained
A.C.E. scores	7	8.234	18.475	Sustained

Normality Tests on Data Relating to 1947-49 Women

High school averages, college averages and A.C.E. scores. Table XVIII provides a summary of the results of normality tests conducted on the high school averages, college averages, and A.C.E. scores of the combined female groups. It will be noted that scores on each of the three variables were found to be normally distributed.

TABLE XVIII

TESTS OF THE GOODNESS OF FIT OF THE DISTRIBUTIONS OF 1947-49 WOMEN'S HIGH SCHOOL AVERAGES,-COLLEGE AVERAGES, AND A.C.E. SCORES TO NORMAL DISTRIBUTIONS

Variable	d.f.	χ^2_o	$\chi^2_{o.ol}$	Hypothesis
High school averages	6	12.648	16.812	Sustained
College Averages	6	6.390	16.812	Sustained
A.C.E. scores	7	5.722	18.475	Sustained

Variability of the Experimental Groups

Since the study in its remaining phase is concerned with two clearly defined groups, a separate treatment of the data relating to the sexes being essential, it was unnecessary to test the sex groups for variability differences. Therefore the F ratios have been employed to

determine whether the combination of the 1947-48 and 1948-49 women's groups was justified with respect to variability.

Variability of the Female Groups

High school averages. In order to test the significance of differences in variability of the female groups with respect to high school average the conventional F ratio was determined and evaluated. Table XIX provides a summary of the results. The observed F was compared with F at the one percent level of significance obtained by entering tables of F with 43 degrees of freedom for the larger variance, and 28 degrees of freedom for the smaller variance. Since the observed F was exceeded by the value of F at the one percent level, the null hypothesis that there was no significant difference between these two variances was sustained.

TABLE XIX

COMPARISON OF THE VARIANCES OF HIGH SCHOOL AVERAGES OF THE 1947-48 AND 1948-49 WOMEN

Group	Variance	d.f.	F_o	$F_{o.01}$	Hypothesis
1947-48 women	0.2641	28			
1948-49 women	0.3590	43			
			1.36	2.34	Sustained

College averages. A description of the data relating to the F test conducted on college averages is presented in table XX. As the observed F was not significant, the null hypothesis was sustained. The groups therefore exhibited no real difference in the variability of their college averages.

TABLE XX

COMPARISON OF THE VARIANCES OF COLLEGE AVERAGES OF THE 1947-48 AND 1948-49 WOMEN

Group	Variance	d.f.	F_o	$F_{o.ol}$	Hypothesis
1947-48 women	1.0656	28			
1948-49 women	0.8939	43			
			1.19	2.19	Sustained

A.C.E. scores. The F test conducted on the A.C.E. scores of the two female groups also revealed no significant difference in variability. Table XXI indicates an observed F of 1.38 as compared with an F value of 2.19 at the one percent level of significance. Hence the null hypothesis was sustained.

TABLE XXI

COMPARISON OF THE VARIANCES OF A.C.E. SCORES OF THE 1947-48 AND 1948-49 WOMEN

Group	Variance	d.f.	F_o	$F_{0.01}$	Null Hypothesis
1947-48 women	443.5911	28			
1948-49 women	321.0417	43			
			1.38	2.19	Sustained

The 1949-50 Group

A summary of the main statistical data relating to the 1949-50 men and women used in this study for purposes of testing both simple and multiple regression equations has been provided in Table V. The groups resemble closely the corresponding experimental groups from which the regression equations were derived. The apparently large A.C.E. means of this group do not differ significantly from the corresponding means of the experimental groups. Table XXII provides a summary of the results of the tests for the significance of mean differences.

TABLE XXII

TESTS OF THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN MEANS OF A.C.E. SCORES OF THE EXPERIMENTAL GROUPS AND THE 1949-50 GROUP

Group	Mean	d.f.	$\bar{d}$	Standard Error	t_o	$t_{.01}$	Hypothesis
1947-48 men	119.2884						
1949-50 men	125.0784	153	5.7900	3.3842	1.71	2.61	Sustained
1947-49 women	116.7123						
1949-50 women	126.5416	95	9.8293	4.4602	2.20	2.63	Sustained

Summary

Three main operations were carried out in the preliminary analysis of the data for the purpose of selecting the final groups. First, analyses of variance were conducted on high school averages, college averages and A.C.E. scores. Significant mean differences were indicated by the analyses between the means of the four study groups on high school averages and A.C.E. scores only. The t tests indicated no significant differences between the means of high school averages in the two male groups, or between the corresponding means of the two female groups. The difference between the means of the two sex groups, however, was significant. The

t test on the means of the A.C.E. scores of the two male groups revealed a significant difference, in view of which the smaller of the groups was excluded from further analysis. It should be noted that a second t test conducted on the means of high school averages of the retained male group and the combined female group indicated the persistence of a significant difference. The A.C.E. means of the two female groups were not significantly different, nor were the means of the retained male group and the combined female groups. Results of this preliminary analysis necessitated not only the exclusion of the 1948-49 males from the study, but the development of separate regression equations for the sexes.

Tests of goodness of fit of the distribution of high school averages, college averages, and A.C.E. scores to normal distributions were conducted for each of the remaining groups employing the chi-square procedure on the observed and expected frequencies. Insignificance of the observed chi-square values indicated normality of distribution of the scores of all groups on each of the three variables.

No significant differences in variability of the scores on the three variables were disclosed by the F tests. This statement applies to both male and female groups when considered separately or when compared.

CHAPTER V

CORRELATION AND SIMPLE REGRESSION

Prior to the calculation of both simple and multiple regression equations, it was necessary to determine the correlations existing between scores on the study variables for the two main sex groups. This chapter provides a description of the correlation results, and the calculation of simple regression equations for the prediction of college averages using either high school averages or A.C.E. scores.

Zero Order Correlations

Three zero order r's were determined for each sex group:

1. the correlation between college averages and A.C.E. scores;
2. the correlation between college averages and high school averages;
3. the correlation between high school averages and A.C.E. scores.

It might be noted that only the first two of the correlations listed are required for purposes of setting up simple regression equations, the third correlation value being required in the calculation of multiple regression equations.

Correlations for 1947-48 men. Table XXIII contains

a summary of the results relating to the intercorrelations between college averages, A.C.E. scores and high school averages of the male group.

TABLE XXIII

THE DETERMINATION OF ZERO ORDER INTERCORRELATIONS BETWEEN COLLEGE AVERAGES, A.C.E. SCORES, AND HIGH SCHOOL AVERAGES FOR THE 1947-48 MEN

Variables	r
College Averages - A.C.E. Scores	0.3778
College Averages - High School Averages	0.3437
A.C.E. Scores - High School Averages	0.0827

It will be noted that the highest correlation of 0.3778 was found between A.C.E. scores and college averages, while the correlations between college averages and high school averages, and between high school averages and A.C.E. scores were 0.3437 and 0.0827 respectively. These coefficients were tested for significance using the t ratio already described. Table XXIV presents a summary of the results. It is evident that the correlations between high school averages and college averages, and between A.C.E. scores and college averages are significant, while the correlation between A.C.E. scores and high school averages was not significant.

TABLE XXIV

TESTS OF THE SIGNIFICANCE OF INTERCORRELATIONS BETWEEN COLLEGE AVERAGES, A.C.E. SCORES, AND HIGH SCHOOL AVERAGES OF THE 1947-48 MEN

Variables	r	d.f.	t_o	$t_{.01}$	Null Hypothesis
College Averages - A.C.E. Scores	0.3778	102	4.12	2.63	Refuted
College Averages - H.S. Averages	0.3437	102	3.70	2.63	Refuted
H.S. Averages - A.C.E. Scores	0.0827	102	0.84	2.63	Sustained

Correlations for 1947-49 women. The procedure for determining correlations between the experimental variables for the female group was identical with that followed in the case of the men. In Table XXV a description of the results of correlation procedures has been provided. Although all correlations are higher, the pattern of differences between them is remarkably similar to that of the male group. A.C.E. scores and college averages correlate 0.5097, high school averages and college averages 0.5232, and high school averages and A.C.E. scores 0.1464.

TABLE XXV

THE DETERMINATION OF ZERO ORDER INTERCORRELATIONS BETWEEN COLLEGE AVERAGES, A.C.E. SCORES AND HIGH SCHOOL AVERAGES FOR THE 1947-49 WOMEN

Variables	r
College Averages - A.C.E. Scores	0.5097
College Averages - High School Averages	0.5232
A.C.E. Scores - High School Averages	0.1464

Tests of significance. Information concerning the tests of significance of the observed r's is presented in Table XXVI. The correlations between college averages and both A.C.E. scores and high school averages were found to be significant. In the case of the correlation between high school averages and A.C.E. scores, the observed t was exceeded by t at the one percent level, and the null hypothesis that the true or population value of the coefficient was zero was therefore sustained.

TABLE XXVI

TESTS OF THE SIGNIFICANCE OF INTERCORRELATIONS BETWEEN COLLEGE AVERAGES, A.C.E. SCORES, AND HIGH SCHOOL AVERAGES OF THE 1947-49 WOMEN

Variables	r	d.f.	t_o	$t_{.01}$	Null Hypothesis
College Averages - A.C.E. Scores	0.5097	71	4.99	2.65	Refuted
College Averages - H.S. Averages	0.5232	71	5.17	2.65	Refuted
H.S. Averages - A.C.E. Scores	0.1464	71	1.25	2.65	Sustained

Development and Trial of Simple Regression Equations

In the development and testing of the regression equations in this section the following symbolism was employed in the case of the 1947-48 males:

X_1 = College Average

X_2 = A.C.E. Score

X_3 = High School Average

X_1' = Estimated College Average

For the 1947-49 women the following symbolism was used:

Y_1 = College Average

Y_2 = A.C.E. Score

Y_3 = High School Average

Y_1' = Estimated College Average

The Prediction of College Averages of the 1949-50 Men

A.C.E. score as a predictor. The derivation of the equation for prediction of college averages of the males when the predictive variable (X_2) is A.C.E. score is illustrated below:

$$X_1' = \frac{r_{12}S.D.(X_1)}{S.D.(X_2)} (X_2 - \bar{X}_2) + \bar{X}_1 \qquad (5.1)$$

$$= \frac{0.3778(0.9498)}{19.8760} (X_2 - 119.2884) + 2.9057$$

$$= 0.0180X_2 + 0.7586 \qquad (5.2)$$

The substitution of a particular A.C.E. score for X_2 in this equation yields an estimate of probable college average which is the estimated college average for a group of individuals with that particular A.C.E. score.

The method of determining the standard error of an estimated score used in this study is one which takes account of the fact that each estimated score has its own standard error, the size of which depends in part upon the deviation of the score on the predictive variable from its mean. The formula for the standard error of an individual predicted score was employed:[1]

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[1] Palmer O. Johnson, Statistical Methods In Research, New York: Prentice-Hall, Inc., 1949, p. 121.

$$S(X_1') = \left\{ \frac{S^2(X_1)\ (1-r_{12}^2)}{N-2} \left[1 + \frac{(X_2-\bar{X}_2)^2}{S^2(X_2)} \right] \right\}^{\frac{1}{2}} \qquad (5.3)$$

where $S^2(X_1)$ = the variance of scores on the criterion.

$S^2(X_2)$ = the variance of scores on the predictive variable of the group used in determining correlation coefficients.

X_2 = an obtained score on the predictive variable.

r_{12} = the correlation between criterion and predictive variables.

It will be noted that the errors of estimate of X_1 increase as X_2 departs from the mean of the X_2 distribution, and that as the values of r and $S(X_2)$ become larger, the smaller become the errors of estimation.[2] The working form of this formula is written:

$$S(X_1') = \left\{ \frac{0.9079(0.8573)}{102} \left[1 + \frac{x_2^2}{394.8286} \right] \right\}^{\frac{1}{2}}$$

$$= \left\{ 0.0076 \left[1 + \frac{x_2^2}{394.8286} \right] \right\}^{\frac{1}{2}} \qquad (5.4)$$

where x_2 = a deviation score.

Table XXVII gives a summary of predictions made on data relating to the group of fifty-one Type C freshmen who were enrolled during the 1949-50 session. A.C.E. scores corresponding to every fifth college average in the distribution of college averages were used to test the regression

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[2] Ibid, p. 121.

equation. Standard errors of estimate were calculated and used to set up confidence intervals. The confidence interval, $X_1' \pm t_{.01} S(X_1')$, containing the actual college average of the student has been underlined in the table.

TABLE XXVII

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 MEN WITH THOSE PREDICTED EMPLOYING THEIR A.C.E. SCORES

A.C.E. Score	Predicted Col. Ave.	Obtained Col. Ave.	$S(X_1')$	$t_{.01}S(X_1')$	Confidence Interval
88	2.3426	2.60	0.1624	0.4271	1.92 - 2.77
112	2.7746	1.80	0.0927	0.2438	2.53 - 3.02
112	2.7746	2.40	0.0927	0.2438	2.53 - 3.02
114	2.8106	3.00	0.0900	0.2367	2.57 - 3.05
116	2.8466	2.20	0.0883	0.2322	2.61 - 3.08
120	2.9186	3.20	0.0872	0.2293	2.69 - 3.15
141	3.2966	3.20	0.1292	0.3398	2.96 - 3.64
143	3.3326	3.80	0.1357	0.3569	2.98 - 3.69
143	3.3326	4.60	0.1357	0.3569	2.98 - 3.69
167	3.7646	4.80	0.2267	0.5962	3.17 - 4.36

Inspection of the table reveals that no particular trend in predictive accuracy is discernible.

High school average as a predictor. The simple regression equation derived for the prediction of college averages of the 1949-50 males from a knowledge of their high school averages is similar in form to the equation derived using A.C.E. scores:

$$X_1' = \frac{r_{13} S.D.(X_1)}{S.D.(X_3)} (X_3 - \bar{X}_3) + \bar{X}_1 \qquad (5.5)$$

$$= \frac{0.3437(0.9498)}{0.6100} \quad (X_3 - 4.0401) + 2.9057$$

$$= 0.5351X_3 + 0.7439 \qquad (5.6)$$

Standard errors were calculated for each predicted college average. The working form of the standard error formula used was:

$$S(X_1') = \left\{ \frac{0.9079(0.8819)}{102} \left[1 + \frac{x_3^2}{0.3657} \right] \right\}^{\frac{1}{2}} \qquad (5.7)$$

$$= \left\{ 0.0078 \left[1 + \frac{x_3^2}{0.3657} \right] \right\}^{\frac{1}{2}} \qquad (5.8)$$

In Table XXVIII are provided the results of predictions made to test high school averages as predictors of the same obtained college averages used in Table XXVII. It will be noted that there appears to be considerable improvement in predictive accuracy over that observed when A.C.E. scores were used as predictors. However the number of predictions is limited, and it is therefore unsafe to generalize.

TABLE XXVIII

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 MEN WITH THOSE PREDICTED EMPLOYING THEIR HIGH SCHOOL AVERAGES

H.S. Ave.	Predicted Col. Ave.	Obtained Col. Ave.	$S(X_1')$	$t_{.01}S(X_1')$	Confidence Interval
3.00	2.3492	2.20	0.1757	0.4620	1.89 - 2.81
3.33	2.5257	2.40	0.1360	0.3576	2.17 - 2.88
3.67	2.7077	2.60	0.1034	0.2719	2.44 - 2.98
3.78	2.7665	1.80	0.0959	0.2522	2.51 - 3.02
4.22	3.0020	3.00	0.0922	0.2424	2.76 - 3.24
4.22	3.0020	3.20	0.0922	0.2424	2.76 - 3.24
4.38	3.0876	3.20	0.1010	0.2656	2.82 - 3.35
4.62	3.2160	4.80	0.1224	0.3219	2.89 - 3.54
5.00	3.4194	3.80	0.1655	0.4352	2.98 - 3.85
5.00	3.4194	4.60	0.1655	0.4352	2.98 - 3.85

The Prediction of College Averages of the 1949-50 Women

A.C.E. score as a predictor. The simple regression equation for the prediction of women's college averages from a knowledge of their A.C.E. scores was derived as follows:

$$Y_1' = \frac{r_{12}S.D.(Y_1)}{S.D.(Y_2)} (Y_2 - \bar{Y}_2) + \bar{Y}_1 \qquad (5.9)$$

$$= \frac{0.5097(0.9696)}{19.1868} (Y_2 - 116.7123) + 2.9924$$

$$= 0.0257Y_2 - 0.0071 \qquad (5.10)$$

The equation was used to estimate college averages from a knowledge of the A.C.E. scores of a number of subjects chosen from the twenty-four students comprising the 1949-50 group of women. The A.C.E. scores used were those correspond-

ing to every third college average in the distribution of college averages of the 1949-50 group. Standard errors were determined for each predicted average and used in the setting up of confidence intervals.

The standard error formula used was:

$$S(Y_1') = \left\{ \frac{0.9486(0.7403)}{71} \left[1 + \frac{y_2^2}{366.7633} \right] \right\}^{\frac{1}{2}} \qquad (5.11)$$

$$= \left\{ 0.0099 \left[1 + \frac{y_2^2}{366.7633} \right] \right\}^{\frac{1}{2}} \qquad (5.12)$$

Table XXIX provides a description of the results. From the limited number of trials made, it is not possible to discern a pattern descriptive of any trend in predictive efficiency.

TABLE XXIX

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 WOMEN WITH THOSE PREDICTED EMPLOYING THEIR A.C.E. SCORES

A.C.E. Score	Predicted Col. Ave.	Obtained Col. Ave.	$S(Y_1')$	$t_{.01}S(Y_1')$	Confidence Interval
119	3.0512	2.00	0.1000	0.2650	2.79 - 3.32
119	3.0512	2.60	0.1000	0.2650	2.79 - 3.32
122	3.1283	3.20	0.1034	0.2740	2.85 - 3.40
126	3.2311	1.60	0.1105	0.2928	2.94 - 3.52
135	3.4624	3.80	0.1375	0.3644	3.10 - 3.83
138	3.5395	4.00	0.1487	0.3941	3.15 - 3.93
156	4.0021	5.00	0.2272	0.6021	3.40 - 4.60
162	4.1563	4.20	0.2556	0.6773	3.48 - 4.83

High school average as a predictor. The regression

equation utilizing high school averages as predictive of college averages of the women was first developed:

$$Y_1' = \frac{r_{13}S.D.(Y_1)}{S.D.(Y_3)} (Y_3 - \bar{Y}_3) + \bar{Y}_1 \qquad (5.13)$$

$$= \frac{0.5232(0.9696)}{0.5647} (Y_3 - 4.3554) + 2.9924$$

$$= 0.8983Y_3 - 0.9200 \qquad (5.14)$$

Using this equation predictions were made to test high school averages as predictors of the same obtained college averages used in Table XXIX. The standard errors and confidence intervals determined are described in Table XXX. The working standard error formula used was:

$$S(Y_1') = \left\{ \frac{0.9486(0.7263)}{71} \left[1 + \frac{y_3^2}{0.3177} \right] \right\}^{\frac{1}{2}} \qquad (5.15)$$

$$= \left\{ 0.0097 \left[1 + \frac{y_3^2}{0.3177} \right] \right\}^{\frac{1}{2}} \qquad (5.16)$$

On the basis of the limited number of predicted averages, there would appear to be little difference in the predictive efficiency of high school averages and A.C.E. scores. This is to be expected in view of the correspondence between the correlation coefficients obtained.

TABLE XXX

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 WOMEN WITH THOSE PREDICTED EMPLOYING THEIR HIGH SCHOOL AVERAGES

H.S. Ave.	Predicted Col. Ave.	Obtained Col. Ave.	$S(Y'_1)$	$t_{.01}(SY'_1)$	Confidence Interval
3.33	2.0713	1.60	0.2051	0.5435	1.53 - 2.61
3.33	2.0713	2.00	0.2051	0.5435	1.53 - 2.61
4.50	3.1223	3.80	0.1014	0.2687	2.85 - 3.39
4.67	3.2750	2.60	0.1123	0.2976	2.98 - 3.57
5.00	3.5715	3.20	0.1490	0.3949	3.18 - 3.97
5.00	3.5715	4.00	0.1490	0.3949	3.18 - 3.97
5.00	3.5715	4.20	0.1490	0.3949	3.18 - 3.97
5.00	3.5715	5.00	0.1490	0.3949	3.18 - 3.97

Summary

The calculation of zero-order correlations for the 1947-48 men revealed low but significant correlations between college averages as the criteria, and high school averages and A.C.E. scores as predictive variables. The correlation between high school averages and A.C.E. scores was not significant. The pattern of correlations found between scores of the female group resembled that found for the males, although the coefficients were considerably higher for the former.

Trial of the simple regression equation using data relating to the 1949-50 group indicated that a greater number of obtained men's college averages fell within their confidence intervals when high school average was used as the predictive

variable. However, in view of the limited number of predictions made it was not possible to generalize.

Fewer of the women's obtained college averages fell within their confidence intervals than were observed in the case of the men. Generally, in view of the fact that t's at the one percent level were used in setting up confidence intervals, the number of "accurate" predictions was not as great as would be expected.

CHAPTER VI

MULTIPLE CORRELATION AND MULTIPLE REGRESSION

The purpose of this section is to develop multiple correlation coefficients and multiple regression equations for both sex groups, and to test the predictive value of the equations using high school averages and A.C.E. scores as joint predictors of college averages. The method of development chosen is based on the calculation of g statistics and standard partial regression coefficients (β's) as described by Johnson.[1]

The Determination of the Multiple Correlation Coefficient and Multiple Regression Equation Based on Data Relating to 1947-48 Men

In the statistical development which follows the following symbolism has been employed:

X_1 = college average.

X_2 = A.C.E. score.

X_3 = high school average.

The numerical subscripts correspond to those used in denoting the various g, β, r, and other statistics in the development described.

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[1] Johnson, op. cit., p. 343.

Calculation of g and β statistics.

$$g_{22} + g_{32}r_{23} = 1 \qquad g_{23} + g_{33}r_{23} = 0$$
$$g_{22} + g_{32}r_{32} = 0 \qquad g_{23}r_{23} + g_{33} = 1 \tag{6.1}$$

From the above equations:

$$g_{22} = \frac{1}{1-r_{23}^2} = \frac{1}{1-(0.0827)^2} = 1.0068$$

$$g_{32} = \frac{-r_{23}}{1-r_{23}^2} = \frac{-0.0827}{1-(0.0827)^2} = -0.0833$$

$$g_{23} = \frac{-r_{23}}{1-r_{23}^2} = \frac{-0.0827}{1-(0.0827)^2} = -0.0833$$

$$g_{33} = \frac{1}{1-r_{23}^2} = \frac{1}{1-(0.0827)^2} = 1.0068$$

Now:

$$\beta_2 = g_{22}r_{12} + g_{23}r_{13} = 1.0068(0.3778)-0.0833(0.3437) = 0.3517$$

$$\beta_3 = g_{32}r_{12} + g_{33}r_{13} = -0.0833(0.3778)+1.0068(0.3437) = 0.3146$$

Determination of R.

$$R_{1.23}^2 = \beta_2 r_{12} + \beta_3 r_{13} \tag{6.2}$$
$$= 0.3517(0.3778)+0.3146(0.3437)$$
$$= 0.241000$$
$$R_{1.23} = 0.4910$$

The obtained R was tested for significance using the F Ratio:

$$F_o = \frac{R^2}{1-R^2}\,\frac{(N-m-1)}{m} \tag{6.3}$$

where m = the number of independent variables.

Table XXXI contains a summary of the results which indicate that the obtained R is significant.

TABLE XXXI

TEST OF THE SIGNIFICANCE OF THE OBTAINED MULTIPLE CORRELATION COEFFICIENT RELATING TO 1947-48 MEN

R	N	m	d.f.(num.)	d.f.(den.)	F_o	$F_{0.01}$	Hypothesis
0.4910	104	2	2	101	16.03	4.82	Refuted

Tests of significance of the β statistics. Before proceeding to use the observed β's in the calculation of regression equations, it was necessary to determine their significance. For this purpose the conventional t ratio was employed:

$$t_2 = \frac{\beta_2}{S(\beta_2)} \qquad t_3 = \frac{\beta_3}{S(\beta_3)} \tag{6.4}$$

$S(\beta_2)$ = the standard error of β_2.

$S(\beta_3)$ = the standard error of β_3.

The standard errors of β_2 and β_3 were calculated using the formulae:

$$S^2(\beta_2) = \frac{1-R^2}{N-m-1} \; g_{22} \tag{6.5}$$

$$S^2(\beta_3) = \frac{1-R^2}{N-m-1} \; g_{33} \tag{6.6}$$

Table XXXII provides a description of the data and results of the test from which it will be noted that both statistics were found to be significant.

TABLE XXXII

TEST OF SIGNIFICANCE OF THE OBTAINED BETAS RELATING TO 1947-48 MEN

Statistic	SE	d.f.	t_0	$t_{0.01}$	Hypothesis
β_2	0.0869	101	4.05	2.63	Refuted
β_3	0.0869	101	3.62	2.63	Refuted

Calculation of the multiple regression equation. The multiple regression equation was calculated as follows:

$$X_1' = \bar{X}_1 + \beta_2 \frac{S_1}{S_2} (X_2 - \bar{X}_2) + \beta_3 \frac{S_1}{S_3} (X_3 - \bar{X}_3). \quad (6.7)$$

$$= 2.9057 + 0.3517 \left(\frac{0.9498}{19.8760}\right) (X_2 - 119.2884)$$

$$+ 0.3146 \left(\frac{0.9498}{0.6100}\right) (X_3 - 4.0400)$$

$$= 0.0168X_2 + 0.4898X_3 - 1.0771. \quad (6.8)$$

The standard error of an estimated score. The method of determining the standard error of a score estimated from a knowledge of scores on two predictive variables is similar to the univariate case in that it takes account of the deviations from their means of the scores on the predictive variables.

The form employed here is that described by Johnson:[2]

$$S_{1.23} = \left\{ \frac{S_1^2(1-R_{1.23}^2)}{N-m-1} \left[1 + \frac{g_{22}}{S_2^2} x_2^2 + \frac{g_{33}}{S_3^2} x_3^2 + \frac{2g_{23}\, x_2 x_3}{S_2 S_3} \right] \right\}^{\frac{1}{2}} \quad (6.9)$$

where x = a deviation score.

The working form of this formula for males may be written thus:

$$S_{1.23} = \left\{ \frac{0.9021(0.7590)}{101} \left[1 + \frac{1.0068}{395.0553} x_2^2 + \frac{1.0068}{0.3721} x_3^2 - \frac{0.1666}{12.1243} x_2 x_3 \right] \right\}^{\frac{1}{2}}$$

$$= \left\{ .0068 \left[1 + 0.0025\, x_2^2 + 2.7057\, x_3^2 - 0.0137\, x_2 x_3 \right] \right\}^{\frac{1}{2}} \quad (6.10)$$

Predictions Using the Multiple Regression Equation on Data Relating to 1949-50 Men

The scores of the same individuals from the 1949-50 male freshman group as were used in the trial predictions employing simple regression equations have been used to test the multiple regression equation. Table XXXIII provides a summary of the data and results.

It will be noted that a greater number of obtained college averages fell within their confidence intervals than when A.C.E. scores alone were employed as predictors. The confidence intervals determined using high school averages, however, contained the same number of obtained college

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[2] Ibid., p. 343.

averages as those found in Table XXXIII. It should be kept in mind that the number of predictions is quite limited, and generalization is therefore unsafe.

TABLE XXXIII

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 MEN WITH THOSE PREDICTED EMPLOYING THEIR A.C.E. SCORES AND HIGH SCHOOL AVERAGES

A.C.E. Score	H.S. Ave.	Predicted College Average	Obtained College Average	$S_{1.23}$	$t_{.01}S_{1.23}$	Confidence Interval
88	3.67	2.1988	2.60	0.1578	0.4150	1.78 - 2.61
112	3.78	2.6559	1.80	0.0936	0.2461	2.41 - 2.90
112	3.33	2.4355	2.40	0.1284	0.3376	2.10 - 2.77
114	4.22	2.9050	3.00	0.0892	0.2345	2.67 - 3.14
116	3.00	2.3411	2.20	0.1629	0.4284	1.91 - 2.77
120	4.38	3.0842	3.20	0.0944	0.2482	2.84 - 3.33
141	4.22	3.3586	3.20	0.1226	0.3224	3.04 - 3.68
143	5.00	3.7743	3.80	0.1766	0.4644	3.31 - 4.24
143	5.00	3.7743	4.60	0.1766	0.4644	3.31 - 4.24
167	4.62	3.9913	4.80	0.2216	0.5828	3.41 - 4.57

The Determination of the Multiple Correlation Coefficient and Multiple Regression Equation Based on Data Relating to 1947-49 Women

The method of determination of the multiple correlation coefficient and the calculation of the multiple regression equation for use in predicting college averages of the women parallels that described in the preceding section for the men.

Y_1 = college average.

Y_2 = A.C.E. score.

Y_3 = high school average.

The same numerical subscripts have been used in denoting corresponding g, β, and r statistics in the development which follows.

Calculation of g and β statistics.

$$g_{22} = \frac{1}{1-r_{23}^2} = \frac{1}{1-(0.1464)^2} = 1.0218$$

$$g_{32} = \frac{-r_{23}}{1-r_{23}^2} = \frac{-0.1464}{0.9786} = -0.1496$$

$$g_{23} = \frac{-r_{23}}{1-r_{23}^2} = \frac{-0.1464}{0.9786} = -0.1496$$

$$g_{33} = \frac{1}{1-r_{23}^2} = \frac{1}{0.9786} = 1.0218$$

Now:

$$\beta_2 = g_{22}r_{12}+g_{23}r_{13} = (1.0218)(0.5097)-(0.1496)(0.5232)=0.4426$$

$$\beta_3 = g_{32}r_{12}+g_{33}r_{13} = (-0.1496)(0.5097)+(1.0218)(0.5232)=0.4584$$

Determination of R.

$$R_{1.23}^2 = \beta_2 r_{12} + \beta_3 r_{13} \qquad (6.2)$$

$$= 0.4426(0.5097) + 0.4584(0.5232)$$

$$= 0.465424$$

$$R_{1.23} = 0.6828$$

The obtained R was then tested for significance. A summary of the results is presented in Table XXXIV, from which it will be noted that R was found to be significant.

TABLE XXXIV

TEST OF THE SIGNIFICANCE OF THE OBTAINED MULTIPLE CORRELATION COEFFICIENT RELATING TO 1947-49 WOMEN

R	N	m	d.f.(num.)	d.f.(den.)	F_o	$F_{0.01}$	Hypothesis
0.6828	73	2	2	70	30.47	4.92	Refuted

Tests of significance of the β statistics. Table XXXV contains data relative to the tests of significance of the observed betas. Both statistics were found to be significant.

TABLE XXXV

TEST OF SIGNIFICANCE OF THE OBTAINED BETAS RELATING TO DATA OF THE 1947-49 WOMEN

Statistics	SE	d.f.	t_o	$t_{.01}$	Hypothesis
β_2	0.0883	70	5.01	2.65	Refuted
β_3	0.0883	70	5.19	2.65	Refuted

Calculation of the multiple regression equation.

$$Y_1' = \overline{Y}_1 + \beta_2 \frac{S_1}{S_2}(Y_2-\overline{Y}_2) + \beta_3 \frac{S_1}{S_3}(Y_3-\overline{Y}_3) \qquad (6.11)$$

$$= 2.9924 + 0.4426 \frac{(0.9696)}{19.1868}(Y_2-116.7123)$$

$$+ 0.4584 \frac{(0.9696)}{0.5647}(Y_3-4.3554)$$

$$= 0.0224Y_2 + 0.7871Y_3 - 3.0501. \qquad (6.12)$$

The standard error of an estimated score.

$$S_{1.23} = \left[\frac{S_1^2(1-R_{1.23}^2)}{N-m-1} \left[1 + \frac{g_{22}}{S_2^2} y_2^2 + \frac{g_{33}}{S_3^2} y_3^2 + \frac{2g_{23}y_2y_3}{S_2S_3} \right] \right]^{\frac{1}{2}} \quad (6.13)$$

$$= \left[\frac{0.9401(0.5346)}{70} \left[1 + \frac{1.0218}{368.1333} y_2^2 + \frac{1.0218}{0.3188} y_3^2 - \frac{0.2992}{10.8348} y_2y_3 \right] \right]^{\frac{1}{2}}$$

$$= \left[0.0072 \left[1 + 0.0028\, y_2^2 + 3.2051\, y_3^2 - 0.0276\, y_2y_3 \right] \right]^{\frac{1}{2}} \quad (6.14)$$

Predictions Using the Multiple Regression Equation on Data Relating to 1949-50 Women

The scores of the same individuals from the 1949-50 women's group as were used in the trial predictions employing simple regression equations have been used to test the multiple regression equation. Table XXXVI contains a summary of the data and results.

TABLE XXXVI

A COMPARISON OF SOME OBTAINED COLLEGE AVERAGES OF THE 1949-50 WOMEN WITH THOSE PREDICTED EMPLOYING THEIR A.C.E. SCORES AND HIGH SCHOOL AVERAGES

A.C.E. Score	H.S. Ave.	Predicted College Average	Obtained College Average	$S_{1.23}$	$t_{.01}S_{1.23}$	Confidence Interval
119	3.33	2.2365	2.00	0.1790	0.4744	1.76 - 2.71
119	4.67	3.2912	2.60	0.0972	0.2576	3.03 - 3.55
122	5.00	3.6182	3.20	0.1291	0.3421	3.28 - 3.96
126	3.33	2.3933	1.60	0.1873	0.4963	1.90 - 2.89
135	4.50	3.5158	3.80	0.1179	0.3124	3.20 - 3.83
138	5.00	3.9766	4.00	0.1187	0.3146	3.66 - 4.29
156	5.00	4.3798	5.00	0.2071	0.5488	3.83 - 4.93
162	5.00	4.5142	4.20	0.2288	0.6063	3.91 - 5.12

It will be noted that there is little difference in respect to the number of obtained college averages falling in their confidence intervals from that observed when high school averages or A.C.E. scores were employed singly as predictors.

Summary

The determination of multiple correlation coefficients using data relating to the 1947-48 men and the 1947-49 women yielded R's of 0.4910 and 0.6828 respectively. Both coefficients were found to be significant.

Multiple regression equations were calculated and tested on the scores of subjects chosen from the 1949-50 group of freshmen. Standard errors of estimated scores were also calculated and used in setting up confidence intervals.

There was little difference in the number of women's obtained college averages that fell within their confidence intervals from that observed when either A.C.E. scores or high school averages were used singly as predictors. There appeared to be little increase in the number of "correct" predictions made on data relating to the men over that observed when high school averages were used singly as predictors, but in view of the number of trial predictions, generalizations would be unsafe.

Seventy percent of the men's obtained college averages

and fifty percent of the women's obtained college averages fell within their confidence intervals.

CHAPTER VII

SUMMARY, INTERPRETATIONS AND CONCLUSIONS

Restatement of the Problem

It was the purpose of this study to investigate grade twelve achievement and score on the American Council on Education Psychological Examination for College Freshmen as predictors of freshman achievement among Type C students in the College of Arts and Science, University of Saskatchewan. Data relate to the students in attendance during the academic years 1947-1948, 1948-1949, and 1949-1950.

Restatement of the Procedure

The plan for solving the problem involved the following sources of data and analytical procedures:

1. Marks on the grade twelve final examinations, score on the A.C.E., and final marks in the Type C classes of the College of Arts and Science constituted the experimental variables. Both college and grade twelve marks were converted to honor-point averages.
2. Subjects involved in the initial analysis of the data included one hundred four men and twenty-nine women of the 1947-48 session, and eighty-nine men and forty-four women of the 1948-49

session. Fifty-one men and twenty-four women of the 1949-50 session comprised the group which was used to test the regression equations developed in this study.

3. Selection of the final groups was the purpose of the preliminary analysis of the data. Analyses of variance were conducted on the high school averages, A.C.E. scores, and college averages of the four initial experimental groups in order to determine the presence or absence of significant mean differences. Conventional t tests were then used to definitely locate the significant differences between the means of any two groups.

4. Since results of the preliminary analysis of the data necessitated exclusion from the study of the 1948-49 males, and separate treatment of the sexes, tests for normality were conducted on the high school averages, A.C.E. scores and college averages of the final groups, the 1947-48 men and the 1947-49 women.

5. F tests for the significance of differences in variability were then conducted on the high school averages, A.C.E. scores and college averages of the 1947-48 and 1948-49 women.

6. Prior to the calculation of regression equations, zero order correlations were found between the high school averages and college averages, between A.C.E. scores

and college averages, and between high school averages and A.C.E. scores for each of the two main groups. These coefficients were tested for significance.

7. Multiple correlation coefficients were also determined and tested for significance.

8. Simple and multiple regression equations using high school averages and A.C.E. scores as predictors of college averages were determined for both men and women, and tested on data relating to the 1949-50 subjects. Confidence intervals were set up for the purpose of indicating the deviation of obtained averages from those predicted employing the regression equations.

Interpretations and Conclusions

A summary in point form of the main statistical findings along with interpretive comments where warranted is presented in this section.

1. Of the t tests conducted on the means of the high school averages of the original four study groups only one indicated a significant mean difference, that relating to the 1947-49 male and female groups. This finding necessitated a separate treatment of data relating to the sexes, since the difference between the sexes on mean high school average persisted even when the 1948-49 males were later

excluded from the analysis.

A number of investigations have disclosed similar significant differences in mean high school achievement favoring the girls. Among these is an investigation by Thiede conducted on Art students at the University of Wisconsin.[1] He quotes similar findings from the incompleted study of Lins. Thiede's discovery that achievement differences disappeared at the college level is in agreement with the findings of this study.

The difference at the high school level probably cannot be explained with any degree of certainty. Burton cites evidence to show that boys must do approximately 14 percent better than girls to achieve comparable standing.[2] On the other hand, it is possible that certain selective factors not disclosed by data contained in the files of the College of Arts and Science may be operating to create such a difference.

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[1]W. B. Thiede, "Some Characteristics of Juniors Enrolled in Selected Curricula at the University of Wisconsin", Journal of Experimental Education, Vol. 19, No. 1, Sept. 1950, p. 22.

[2]W. H. Burton, The Guidance of Learning Activities, New York: Appleton-Century-Crofts, Inc., p. 487.

2. No significant differences were found between the means of college averages of any of the groups concerned in this study. As noted above the sex difference with respect to achievement at the high school level did not persist at the college level for these particular groups.
3. Although no significant difference in mean A.C.E. score was noted in the 1947-48 and 1948-49 female groups, the means of the corresponding male groups were significantly different. For this reason the 1948-49 males were excluded from further analysis. A t test on the A.C.E. means of the remaining male group and 1947-49 female group indicated no significant difference.

It is possible that selective factors, which the author was unable to determine, may account for the difference noted in the mean A.C.E. scores of the two male groups. It does seem feasible that fluctuations in Saskatchewan's fluid economy may exert an appreciable effect on the nature of the student body by selecting students from the upper economic brackets. The lack of a significant sex difference with respect to mean A.C.E. score is also of some interest when considered in the light of the significant mean difference noted in the high school averages of the sex groups. However, as has been noted below, the correl-

ation between A.C.E. scores and high school averages is low. In considering the significance of mean differences noted above, it should perhaps be pointed out that although tests of significance were run at the one percent level, the operation of chance factors is, of course, not entirely removed.

4. The scores of all groups on the three study variables were found to be normally distributed.
5. The F tests revealed no significant differences in variability between any of the experimental groups with respect to high school averages, college averages, or A.C.E. scores. The combination of groups finally made was based on comparability of both their means and standard deviations on criterion and predictive variables.
6. The correlations between the 1947-48 men's college averages and their high school averages and A.C.E. scores were 0.3437 and 0.3778 respectively. The correlation between the high school averages of this group and their A.C.E. scores was 0.0827.

The first two coefficients noted are considerably lower than the corresponding median coefficients noted in Garrett's summary study described in Chapter II. This fact may be due to the operation of selective factors, one of which may be the University's admission

requirement of a minimum high school average of 60 percent. In addition the exclusion from the study of those students who dropped a class or classes for various reasons before the end of term, might exert a depressing effect on the correlation coefficient by eliminating a number of low achievers and thus possibly eliminating also a number with low A.C.E. scores.

The correlations of college average with high school average and A.C.E. scores found in the Laycock-Hutcheon study of University of Saskatchewan freshman engineers in 1937 were 0.61 and 0.34 respectively.[3] These correlations are probably not directly comparable with the corresponding coefficients in this study because of differences in college subject patterns of the groups used, but it would be of interest to know whether particular selective factors operate in the different colleges to account for the difference noted in the high school average - college average correlation coefficients in the two studies. The investigators however found a correlation of over 0.50 between the A.C.E. scores and college averages of a control group

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[3]S. R. Laycock and N. B. Hutcheon, "A Preliminary Investigation into the Problem of Measuring Engineering Aptitude", Journal of Educational Psychology, Vol. 30, April 1939, p. 284.

of one hundred ninety-seven Arts and Science freshmen.[4] Apparently the group consisted of students registered in various types of courses in the college concerned.

The very low and insignificant correlation existing between high school averages and A.C.E. scores in the present study when the correlations of both with college averages yield results that are almost identical, indicates that the A.C.E. is primarily intended for use with college rather than high school students.

7. The correlations between the 1947-49 women's college averages and their high school averages and A.C.E. scores were 0.5232 and 0.5097 respectively. The correlation between the high school averages and A.C.E. scores of this group was 0.1464, which was found to be insignificant.

It will be noted that these coefficients are considerably higher than the corresponding coefficients found for the male group, although the pattern of observed differences is similar. It was not possible to determine from the information in the subjects' files factors which might account for these observed differences in the size of correlation coefficients relating to the sexes. Garrett in his summary study

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[4] Ibid., p. 283.

notes that on the basis of r's obtained for the sexes in a large number of studies using various predictive variables, the college scholarship of women can be more accurately predicted than can that of men.[5]

8. The trial of the simple regression equations using high school averages as predictors of college averages of a limited number of male and female students chosen from the 1949-50 group revealed that 70 percent of the men's obtained college averages fell within their relative confidence intervals, while 38 percent of the women's obtained college averages fell within their respective confidence intervals. The corresponding percentages when A.C.E. scores were used as predictors were 30 and 38 for the men and women respectively.

In evaluating these results it should be kept in mind that they are derived from trials conducted on a very small number of subjects, and that the figures might change considerably with a larger number of trial predictions.

9. Significant multiple correlation coefficients of 0.4910 and 0.6828 were obtained for the men and women respectively. The coefficients, both considerably higher than the corresponding zero order coefficients, give

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[5] Garrett, op. cit., p. 110.

perhaps some indication of the increase in predictive efficiency that may be obtained through use of the multiple regression technique. In Table IV, page 30, a summary of a number of studies involving psychological test scores and high schoolmarks as predictive of college success indicates a median multiple correlation coefficient of 0.63, and a range of 0.48 to 0.79.

10. The trial of the multiple regression equations on data relating to the 1949-50 men revealed that 70 percent of the obtained college averages fell within their respective confidence intervals, which was the same percentage of "correct" predictions noted when high school averages were used singly as predictors. Fifty percent of the women's obtained college averages fell within their corresponding confidence intervals, as compared with 38 percent when either A.C.E. scores or high school averages were used singly as predictors. It should be noted also that a number of obtained college averages narrowly missed falling within their confidence intervals. In the predictions of college averages of the males using the multiple regression equation, an additional two obtained college averages were within 0.36 and 0.23 honor points of the upper limits of their confidence intervals. In the case of

the prediction of women's college averages, an additional two obtained college averages were within 0.08 and 0.30 honor points of the lower limits, and a third was within 0.07 honor points of the upper limit of its confidence interval. These results should be considered in the light of the number of trial predictions made.

It is apparent that the regression equations developed in this study, particularly the multiple regression equations, have some value as predictors of college freshman success in the College of Arts and Science among Type C students. Although it is generally not advisable to base major decisions in educational guidance on knowledge of standing on a single predictive variable, the writer believes that there is sufficient justification for the use of the high school averages and A.C.E. scores of students for counseling purposes among groups similar to those used in this study.

Suggestions for Further Study

1. A comparative study of A.C.E. scores or high school averages as predictors of college achievement among students registered in different colleges would add to our knowledge of the value of these entrance criteria for use with various groups.

2. A further study might be made of the predictive value of various high school subjects and subject teams. Such a study would throw some light on the problem of entrance requirements and the validity of setting up rigid subject prerequisites for admission.
3. It might be of value from a guidance or administrative point of view to study the predictive value of first term marks. The exclusion from a study based on final college marks, of those students who withdraw before the end of the final term, or cancel classes for various reasons, discards data reflecting a pattern characteristic of a section of any normal college freshman population.
4. Relatively few predictive studies of a longitudinal nature have been made. Where a particular freshman group could be followed through to the senior year with respect to college averages, or achievement in special subjects in relation to college average, the possibilities of differential prognosis and individual guidance in such groups might be more clearly understood.
5. There is considerable disagreement regarding the wisdom of the linguistic-quantitative division of the A.C.E. test items from the viewpoint of utility. Studies of the correlation between scores on the Q and L sections and performance in various subjects

or subject fields would reveal the differential predictive value of these sections, and perhaps add to our knowledge of the nature of mental processes in general.

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APPENDICES

APPENDIX A

STUDIES MADE OF STUDENTS' RANK IN HIGH SCHOOL GRADUATING CLASS AND THEIR GRADES IN COLLEGE[1]

Date	Institution	Variable	No. of Students	Time	r
1920	Northwestern Univ.	H.S. Rank	136	1 yr.	.62
1921	California Univ.	H.S. Grades	143	1 sem.	.56
1921	Minnesota Univ.	H.S. %ile		1 sem.	.63
1923	Minnesota Univ.	H.S. %ile	men	1 sem.	.72
1923	Minnesota Univ.	H.S. %ile	women	1 sem.	.68
1928	Macalester College	H.S. Rank	126 w.	1 sem.	.69
1928	Macalester College	H.S. Rank	132 m.	1 sem.	.69
1928	Macalester College	H.S. Rank	both	1 sem.	.68
1928	Macalester College	H.S. Rank	both	1 yr.	.67
1929	Yale Univ.	H.S. Class	501 m.	1 yr.	.61
1931	Yale Univ.	H.S. Rank	3277	1 yr.	.57
1926	Minnesota Univ.	H.S. %ile	300 m.	1 qtr.	.68
1926	Minnesota Univ.	H.S. %ile	287 w.	1 qtr.	.63
1931	Long Beach Jr. Col.	H.S. A's & B's	90 w.		.42
1931	Minnesota Univ.	H.S. Rank	300		.27
1931	Minnesota Univ.	H.S. Rank	229		.49
1927	Oregon Univ.	Principal's Quartile Rating of:			
		School Apt.	385	5 qtrs.	.48
		Industry	385	5 qtrs	.38
		Lead'ship	385	5 qtrs	.18
		Citiz'ship	385	5 qtrs	.26
1933	Minnesota Univ.	H.S. %ile	379	1 qtr.	.47
1934	Minnesota Univ.	H.S. %ile	951	1 qtr.	.45
1934	Minnesota Univ.	H.S. %ile	283	1 qtr.	.52
1934	Minnesota Univ.	H.S. %ile	190		.43
1935	Minnesota Univ.	H.S. %ile	827	2 yrs.	.54
1936	Trenton S.T.C.	H.S. Q'ile	228	1 sem.	.26
1936	Trenton S.T.C.	H.S. Q'ile	123	1 sem.	.30
1937	Marquette Univ.	H.S. Rank	750	1 sem.	.56
1939	Illinois Univ.	H.S. Rank	3006	1 yr.	.60

Number of Coefficients = 29
Range = .18 to .72
Median = .548

[1]H. F. Garrett, "A Review and Interpretation of Investigations of Factors Related to Scholastic Success in Colleges of Arts and Science and Teachers Colleges", Journal of Experimental Education, Vol. 18, No. 2, December 1949, p. 97.

APPENDIX B

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-48 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	5.00	4.78	122
2	5.00	5.00	173
3	4.60	4.75	126
4	4.40	2.75	173
5	4.40	4.12	107
6	4.40	4.89	142
7	4.20	4.88	134
8	4.20	4.44	125
9	4.20	4.00	133
10	4.20	4.75	125
11	4.20	4.38	108
12	4.20	3.56	126
13	4.00	4.88	123
14	4.00	4.88	95
15	4.00	3.62	128
16	4.00	5.00	101
17	4.00	3.50	165
18	4.00	4.11	104
19	4.00	5.00	104
20	3.80	4.88	128
21	3.80	4.67	141
22	3.60	4.00	123
23	3.60	4.75	125
24	3.60	4.25	125
25	3.60	4.33	102
26	3.60	4.00	96
27	3.60	3.67	102
28	3.60	4.62	104
29	3.60	3.00	132
30	3.40	4.56	125
31	3.40	4.12	123
32	3.40	3.67	118
33	3.40	4.56	149
34	3.40	3.62	154
35	3.40	3.14	153
36	3.40	4.22	148
37	3.20	2.89	132
38	3.20	3.50	126
39	3.20	4.44	161
40	3.20	4.56	125

APPENDIX B (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-48 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
41	3.20	4.33	116
42	3.20	4.78	161
43	3.20	2.56	96
44	3.20	3.50	112
45	3.20	4.29	136
46	3.20	4.00	117
47	3.20	4.75	125
48	3.20	3.56	108
49	3.00	4.62	102
50	3.00	3.67	101
51	3.00	4.44	139
52	3.00	4.25	126
53	3.00	4.00	122
54	3.00	4.12	116
55	3.00	3.22	123
56	3.00	4.12	134
57	2.80	4.88	100
58	2.80	4.44	153
59	2.80	4.56	101
60	2.80	4.67	90
61	2.80	4.44	102
62	2.60	4.22	152
63	2.60	4.44	146
64	2.60	4.00	129
65	2.60	2.62	100
66	2.60	4.50	105
67	2.40	3.25	106
68	2.40	4.22	105
69	2.40	3.25	129
70	2.40	3.50	110
71	2.40	3.88	114
72	2.40	3.00	96
73	2.40	3.57	101
74	2.40	4.67	90
75	2.40	4.38	113
76	2.40	4.00	114
77	2.20	3.62	134
78	2.20	4.44	123
79	2.20	4.62	110
80	2.20	3.00	123

APPENDIX B (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-48 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
81	2.20	4.33	99
82	2.20	3.78	113
83	2.20	3.00	104
84	2.00	3.56	107
85	2.00	4.33	125
86	2.00	4.38	118
87	2.00	3.67	93
88	1.80	4.33	117
89	1.80	4.38	123
90	1.80	3.75	164
91	1.60	4.22	104
92	1.60	3.50	118
93	1.60	3.67	102
94	1.60	3.00	109
95	1.60	3.12	91
96	1.40	4.00	104
97	1.40	4.33	101
98	1.40	3.67	110
99	1.20	3.67	110
100	1.20	3.25	74
101	1.20	4.44	98
102	1.00	3.56	127
103	1.00	3.62	123
104	1.00	3.50	86

APPENDIX C

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-48 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	4.80	5.00	126
2	4.80	4.11	142
3	4.60	5.00	147
4	4.60	5.00	158
5	4.00	5.00	120
6	3.80	5.00	145
7	3.60	4.25	153
8	3.60	4.56	129
9	3.60	4.12	129
10	3.40	4.11	102
11	3.30	3.14	138
12	3.20	4.78	134
13	3.20	4.62	109
14	3.20	4.66	123
15	3.20	4.38	85
16	3.00	4.22	129
17	2.80	4.00	101
18	2.60	4.50	98
19	2.40	4.88	92
20	2.20	4.78	118
21	2.20	4.00	120
22	2.20	4.75	125
23	2.20	4.00	92
24	2.00	4.62	112
25	2.00	4.75	107
26	1.60	3.38	70
27	1.50	4.33	102
28	1.40	3.67	110
29	1.20	3.57	125

APPENDIX D

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1948-49 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	5.00	5.00	143
2	4.80	5.00	139
3	4.80	4.25	123
4	4.80	4.78	130
5	4.80	4.88	123
6	4.60	4.00	141
7	4.40	4.75	143
8	4.40	4.11	136
9	4.20	4.88	110
10	4.20	5.00	127
11	4.20	4.22	116
12	4.00	4.78	111
13	4.00	3.56	89
14	4.00	4.78	125
15	3.80	4.67	121
16	3.80	4.33	126
17	3.80	3.67	119
18	3.80	5.00	123
19	3.80	5.00	108
20	3.80	4.78	122
21	3.60	4.50	92
22	3.60	4.56	82
23	3.60	4.88	140
24	3.40	5.00	103
25	3.20	3.00	105
26	3.20	4.33	114
27	3.20	3.62	124
28	3.00	4.00	137
29	3.00	4.38	93
30	3.00	4.00	90
31	3.00	4.00	97
32	3.00	2.89	78
33	3.00	4.78	126
34	3.00	3.78	98
35	3.00	3.44	112
36	3.00	4.50	84
37	2.80	4.00	145
38	2.80	4.11	91
39	2.80	3.62	111
40	2.80	4.50	95

APPENDIX D (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1948-49 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
41	2.80	3.62	93
42	2.80	4.75	120
43	2.80	4.75	98
44	2.80	3.00	126
45	2.60	4.33	110
46	2.60	4.00	99
47	2.60	4.78	89
48	2.60	3.75	103
49	2.60	4.78	103
50	2.40	4.00	138
51	2.40	3.25	125
52	2.40	3.50	107
53	2.40	3.75	108
54	2.40	3.50	85
55	2.20	3.75	112
56	2.20	3.25	86
57	2.20	3.22	126
58	2.20	3.56	118
59	2.20	4.00	94
60	2.20	4.67	78
61	2.20	3.44	121
62	2.20	4.25	110
63	2.00	3.62	107
64	2.00	3.00	78
65	2.00	3.33	115
66	2.00	3.11	105
67	2.00	3.78	67
68	1.80	3.00	107
69	1.80	4.22	124
70	1.80	3.00	93
71	1.80	4.25	129
72	1.60	3.56	110
73	1.60	3.00	109
74	1.60	3.38	97
75	1.60	3.67	116
76	1.40	4.00	104
77	1.40	3.25	140
78	1.40	3.50	106
79	1.40	3.25	100
80	1.20	3.00	136

APPENDIX D (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1948-49 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
81	1.20	4.67	115
82	1.20	4.00	82
83	1.20	4.78	100
84	1.20	2.56	44
85	1.20	3.11	92
86	1.20	3.11	118
87	1.00	3.12	134
88	1.00	2.75	86
89	1.00	2.88	74

APPENDIX E

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1948-49 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	5.00	5.00	149
2	4.40	5.00	117
3	4.40	4.88	151
4	4.20	5.00	144
5	4.20	5.00	143
6	4.20	5.00	106
7	4.00	5.00	127
8	4.00	4.12	112
9	4.00	4.62	106
10	3.80	4.62	94
11	3.80	5.00	130
12	3.80	4.44	131
13	3.80	4.50	130
14	3.60	5.00	104
15	3.60	4.50	100
16	3.60	5.00	96
17	3.40	4.25	133
18	3.20	3.50	137
19	3.20	4.00	77
20	3.00	5.00	127
21	3.00	4.62	113
22	3.00	4.50	117
23	3.00	4.67	115
24	3.00	4.00	128
25	3.00	4.25	125
26	2.80	4.62	102
27	2.60	2.55	152
28	2.60	4.33	102
29	2.60	3.62	116
30	2.60	3.88	121
31	2.40	3.00	118
32	2.40	4.88	100
33	2.25	4.25	111
34	2.20	4.22	112
35	2.20	3.00	93
36	2.20	4.38	122
37	2.00	4.44	92
38	2.00	4.00	109
39	2.00	4.00	96
40	1.60	4.56	118

APPENDIX E (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1948-49 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
41	1.60	4.33	87
42	1.60	3.62	90
43	1.40	4.00	114
44	1.00	3.62	112

APPENDIX F

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-49 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	5.00	5.00	149
2	4.80	5.00	126
3	4.80	4.11	142
4	4.60	5.00	147
5	4.60	5.00	158
6	4.40	5.00	117
7	4.40	4.88	151
8	4.20	5.00	144
9	4.20	5.00	143
10	4.20	5.00	106
11	4.00	5.00	120
12	4.00	5.00	127
13	4.00	4.12	112
14	4.00	4.62	106
15	3.80	5.00	145
16	3.80	4.62	94
17	3.80	5.00	130
18	3.80	4.44	131
19	3.80	4.50	130
20	3.60	4.25	153
21	3.60	4.56	129
22	3.60	4.12	129
23	3.60	5.00	104
24	3.60	4.50	100
25	3.60	5.00	96
26	3.40	4.11	102
27	3.40	4.25	133
28	3.30	3.14	138
29	3.20	4.78	134
30	3.20	4.62	109
31	3.20	4.66	123
32	3.20	4.38	85
33	3.20	3.50	137
34	3.20	4.00	77
35	3.00	4.22	129
36	3.00	5.00	127
37	3.00	4.62	113
38	3.00	4.50	117
39	3.00	4.67	115
40	3.00	4.00	128

APPENDIX F (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1947-49 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
41	3.00	4.25	125
42	2.80	4.00	101
43	2.80	4.62	102
44	2.60	4.50	98
45	2.60	2.55	152
46	2.60	4.33	102
47	2.60	3.62	116
48	2.60	3.88	121
49	2.40	4.88	92
50	2.40	3.00	118
51	2.40	4.88	100
52	2.25	4.25	111
53	2.20	4.78	118
54	2.20	4.00	120
55	2.20	4.75	125
56	2.20	4.00	92
57	2.20	4.22	112
58	2.20	3.00	93
59	2.20	4.38	122
60	2.00	4.62	112
61	2.00	4.75	107
62	2.00	4.44	92
63	2.00	4.00	109
64	2.00	4.00	96
65	1.60	3.38	70
66	1.60	4.56	118
67	1.60	4.33	87
68	1.60	3.62	90
69	1.50	4.33	102
70	1.40	3.67	110
71	1.40	4.00	114
72	1.20	3.57	125
73	1.00	3.62	112

APPENDIX G

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1949-50 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	4.80	4.62	167
2	4.80	5.00	138
3	4.80	5.00	173
4	4.80	5.00	136
5	4.60	5.00	143
6	4.60	5.00	120
7	4.60	5.00	145
8	4.40	5.00	150
9	4.40	5.00	129
10	4.20	4.78	148
11	4.20	4.88	121
12	3.80	4.56	151
13	3.80	4.67	141
14	3.80	5.00	143
15	3.40	4.33	154
16	3.20	4.00	128
17	3.20	3.88	150
18	3.20	3.33	89
19	3.20	4.25	132
20	3.20	3.75	135
21	3.20	4.22	141
22	3.20	4.25	111
23	3.20	4.33	125
24	3.20	4.22	127
25	3.20	4.38	120
26	3.00	4.22	114
27	3.00	4.11	131
28	3.00	3.75	109
29	3.00	4.44	107
30	2.60	2.75	118
31	2.60	2.87	110
32	2.60	4.00	129
33	2.60	3.67	88
34	2.40	3.78	145
35	2.40	3.25	113
36	2.40	4.38	118
37	2.40	3.50	103
38	2.40	3.33	112
39	2.20	4.78	103
40	2.20	4.22	135

APPENDIX G (Continued)

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1949-50 MEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
41	2.20	4.67	108
42	2.20	3.56	116
43	2.20	3.00	116
44	2.00	3.22	123
45	2.00	3.56	95
46	1.80	4.25	135
47	1.80	3.78	112
48	1.60	2.56	104
49	1.40	2.75	127
50	1.40	3.00	83
51	1.40	4.22	108

APPENDIX H

COLLEGE HONOR-POINT AVERAGES, HIGH SCHOOL HONOR-POINT AVERAGES AND A.C.E. SCORES OF THE 1949-50 WOMEN

Subject	College Honor-Point Average	High School Honor-Point Average	A.C.E. Score
1	5.00	5.00	156
2	4.40	5.00	132
3	4.20	4.75	83
4	4.20	5.00	153
5	4.20	5.00	162
6	4.00	5.00	138
7	4.00	4.78	138
8	3.80	4.50	135
9	3.80	4.75	147
10	3.80	4.75	111
11	3.60	3.56	112
12	3.40	4.22	126
13	3.20	5.00	122
14	2.80	3.75	132
15	2.60	2.78	131
16	2.60	4.67	119
17	2.40	4.88	130
18	2.20	4.22	117
19	2.00	3.33	119
20	2.00	3.12	127
21	1.60	3.33	126
22	1.60	4.00	115
23	1.40	4.11	114
24	1.00	4.33	92