1956

Prediction of First Year Mathematic Grades at Central Washington College of Education with the ACE Psychological Examination

Mary Ann Wining
Central Washington University

PREDICTION OF FIRST YEAR MATHEMATIC GRADES AT CENTRAL WASHINGTON COLLEGE OF EDUCATION WITH THE ACE PSYCHOLOGICAL EXAMINATION

A Thesis

Presented to

the Graduate Faculty

Central Washington College of Education

In Partial Fulfillment

of the Requirements for the Degree

Master of Education

---

by

Mary Ann Wining

June 1956

APPROVED FOR THE GRADUATE FACULTY

_____

Eldon E. Jacobsen, COMMITTEE CHAIRMAN

_____

Bruce Alan Robinson

_____

Dean Stinson

TABLE OF CONTENTS

CHAPTER I

THE PROBLEM

Central Washington College of Education was established by the first state legislature in 1890. The first name, Washington State Normal School at Ellensburg, was changed in 1937 to its present name. Through the sixty-five years the college has served the citizens of the state of Washington, it has undergone many changes in its curriculum. In 1933 the legislature authorized the College to grant the Bachelor of Arts degree. In 1947 the College was authorized to grant the Bachelor or Arts degree in Arts and Sciences and the Master of Education degree and in 1949 the college had the authorization to prepare secondary school teachers and to grant the Master of Education degree at the secondary level.[1] In addition Central Washington College of Education performs the following functions:

> . . . (3) the offering of junior college opportunities for students who wish one or two years of college education; (4) the providing of pre-professional work in a variety of fields; and (5) the offering of business education and secretarial training programs.[2]

The student personnel program numbers among its goals of development objective individual appraisal and has given entrance examinations to all freshman and transfer students for the past twenty-four years. All students take one or more of the following tests: (1) American Council on Education Psychological Examination (here after referred to as the ACE);

---

[1] The Quarterly of the Central Washington College of Education, Ellensburg, Washington: 46:21, July, 1954.

[2] Ibid., p. 19.

(2) Cooperative English Test; and (3) Nelson-Denny Reading Test.[3]

> The purpose of these tests is to provide useful information concerning the educational background of entering students. This information is then available to faculty counselors and is employed in personal conferences with students for planning a study schedule, selection of courses, and meeting other college study problems.[4]

Continued research is necessary on tests used in college entrance examinations to provide information that will make the test results increasingly useful. The writer has chosen to study the ACE in order to provide additional empirical information concerning its specific usefulness in relation to courses in mathematics at Central Washington College of Education (CWCE).

Anastasi states that "Test validity concerns what the test measures and how well it does so."[5] The most familiar method of reporting test validity is through a validity coefficient, showing the correlation between test and criterion. Crawford and Burnham make the following statements in reference to correlation coefficients:

> They afford an index of how much dependence can be placed upon guidance measures under circumstances like those wherein the original correlations with appropriate criteria were derived. Just because some test acted in a certain way (yielded a high r) in X situation, it should not be assumed that it will operate likewise in situation Y or Z.
>
> To be meaningful . . . validity should, whenever possible, be determined locally and anew (even within successive classes at the same institution) rather than by mere inference from previously obtained data. Unless clear evidence exists that such inference is

---

[3]E. E. Samuelson, "The 1954-1955 College Testing Program," Unpublished Study at Central Washington College of Education, pp. 1-10.

[4]Quarterly, op. cit., p. 39.

[5]Anne Anastasi, Psychological Testing (New York: MacMillan Company, 1955), p. 120.

actually justified by a known comparability among testing conditions, range of talent, criteria, etc., from one situation to another, it cannot be taken for granted.[6]

MacPhail also states:

. . . that any institution intending serious use of the Q and L scores for guidance purposes might very well discover for itself and on the basis of local data what demonstrable meanings these scores have for that particular institution.[7]

I. STATEMENT OF THE PROBLEM

The purposes of this study are: (1) to acquaint the reader with some of the studies already published on the relationship between the ACE and mathematic grades and other devices for predicting success in mathematics; (2) to present information on the relationship between the ACE and the first year mathematics grades at Central Washington College of Education; and (3) to present information on the relationship between grades in the different mathematics classes taught primarily during the freshman year at CWCE.

II. IMPORTANCE OF THE STUDY

Many studies have been published on the validity of the ACE at different colleges and universities, yet only one such study has been conducted at this institution.[8] The study by O'Donahue correlates the freshman year grade point averages with scores in the ACE and with scores

---

[6]Crawford and Burnham, Forecasting College Achievement (New Haven: Yale University Press, 1946), p. 47.

[7]Andrew H. Mac Phail, "Q and L Scores on the ACE Psychological Examination," School and Society, 56:248-251, 1942.

[8]John O'Donahue, "The Relationship Between Freshman Entrance Examination Scores and Academic Success in the Curriculum of Central Washington College of Education," Unpublished Masters Thesis, Central Washington College of Education, June, 1951.

on the Nelson-Denny Reading Test. To use the ACE effectively in guiding the students toward successful goals, additional studies need to be undertaken in the different academic fields of specialization. This present study takes into consideration only the mathematics classes commonly taken during the freshman year.

It is the hope of the writer that the information presented in this study will be used by the faculty members who are counselors at CWCE toward more specific use and interpretation of the ACE scores and previous mathematics grades when predicting student achievement in subsequent mathematics courses.

III. LIMITATIONS OF THE STUDY

One of the most frequent limitations mentioned in studies on academic work is instructors' marks. As Guilford states it:

> "There is another factor working against fair tests of validity. . . . This factor is indiscriminate pooling of marks from different subjects and from different instructors and treating them as if they were of the same coin. Any cursory inspection of grade distributions in a single institution of learning will show that marks are not by any means of constant value when obtained from different sources."[9]

Fusfeld points out that some reasons why grade point averages are not an adequate indicator of college achievement are the following: (1) the time and energy absorbed by organized athletic pursuits; (2) the need for some students to spend time earning part or all of their support; and (3) the participation in the many and varied extra-curricular

---

[9]J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw Hill Book Company, Inc., 1942), p. 250.

activities now considered so important.[10] Since the above restrictions mentioned by Fusfeld cannot be entirely eliminated or reduced at this institution, the writer has chosen to only point out these limitations. However, the writer has tried to eliminate the pooling of grade averages by keeping each instructor and each class separate in the statistical work and write-up.

The small number of students in each class is another limitation. One explanation of this could be the small number of students majoring or minoring in mathematics. One class, Mathematics 57 (College Algebra II), was added during the 1954-55 school year. A possible explanation for the small number of students in Mathematics 54 and Mathematics 55 (Mathematical Analysis) is that the class is recommended for pre-engineers and for physical science majors,[11] of which, there are currently very few at this institution.

---

[10]Irving S. Fusfeld, "On the ACE Psychological Examination," School and Society, 70:118, August 20, 1949.

[11]The Quarterly of the Central Washington College of Education, Ellensburg, Washington, 46:174-175, July, 1954.

CHAPTER II

THE PROCEDURES EMPLOYED

Studies in guidance and counseling, as well as other fields, can best be interpreted when the procedures employed are carefully described so that one can determine whether the results are likely to be applicable in the situation of concern to the reader. Replication of studies for verification of results also require careful description of procedures.

I. THE STUDY SAMPLE

The students who enrolled in freshman mathematics courses during the 1953-1954 and the 1954-1955 school years were used as the study sample. Two-hundred and ninty-four students were listed as taking mathematics classes during the two year period. Out of the 294 students fourteen withdrew from the classes, two students had no records available, two students were classified as special students and therefore did not take the ACE, one student received no grade, and three students had only the Total (T) score on record. The three students with only T scores available were used for correlation coefficients between the class examinations scores and the T score on the ACE for those classes in which the students were enrolled. This left a total of 275 for the statistical study. McNemar has clarified the sampling problem:

> In the absence of any obviously valid scheme for drawing the sample the only thing one can do is to describe the samples as completely as possible with regards to the known characteristics of the universe from which it was drawn. If the sample is typical of the universe in several variables which are related to the variate being studied, it is safe to assume that it is representative.[12]

---

[12] Q. McNemar, "Sampling in Psychological Research," The Psychological Bulletin, 37:384, 1940.

Before the fourteen students who had withdrawn from classes could be eliminated, it was necessary to determine if they had withdrawn because of unsatisfactory scholastic achievement as measured by the ACE. The T score centiles, based on the national all college norms, ranged from two to eighty-seven with the third quartile at forty-two, the median at twenty, and the first quartile at the seventh centile. The study sample contained students whose ACE centiles on national norms ranged from the first centile to the ninty-ninth centile. The study sample's seventy-fifth centile equalled the sixth-ninth centile on the national norms, their median was equal to the forty-sixth centile and their first quartile equalled the nineteenth centile on the national all college norms. The summary of the data can be found in Table I. The writer found the sample study group higher than the group that withdrew from the classes; hence it is reasonable to state that the correlation coefficients reported in this study are probably slightly attenuated owing to the restriction of the range.

Comparing the sample study group of 275 students with the CWCE population during the two-year study period and the all time CWCE population that has taken the ACE, the writer found the sample group to be above average (Table II). The median of the study sample group was the forty-sixth centile, while the median of the CWCE freshmen, 1954-1955 and 1953-1954, was the thirty-eighth centile. The over all CWCE medians ranged from the thirth centile on national norms to the forty-sixth centile for the years 1938-1952.[13]

---

[13]E. E. Samuelson, "The 1954-1955 College Testing Program," Unpublished Study at Central Washington College of Education, 1954.

TABLE I

Summary Of Test Performance On The ACE
Of The Study Sample Group Compared
With The Students Who Withdrew From Class

	National College Freshman Percentile Equivalents
1. Study Sample	
75th Percentile	69
Median	46
25th Percentile	19
2. Students Who Withdrew From Class	
75th Percentile	42
Median	20
25th Percentile	7

TABLE II

Summary Of Test Performance On The ACE Of The Study Sample Group Compared With College Freshman, 1954-1955, College Freshman, 1953-1954, and for Period 1938-1952.

	National College Freshmen Percentile Equivalents
1. Study Sample	
75th Percentile	69
Median	46
25th Percentile	19
2. Freshmen, 1954-1955*	
75th Percentile	63
Median	38
25th Percentile	17
3. Freshmen, 1953-1954*	
75th Percentile	65
Median	38
25th Percentile	16
4. Freshmen, 1938-1952*	
75th Percentile	58-70
Median	30-46
25th Percentile	13-24

*Data From E. E. Samuelson, "The 1954-1955 College Testing Program," Unpublished Study at Central Washington College of Education

Because the study sample group is above average of the CWCE entrants does not necessarily mean that the sample group is not a true sample of the college population who take mathematics. It may point out that students with higher score averages tend to be more interested in mathematics.

However, as Edwards states:

> In the behavioral sciences we may recognize and acknowledge that we never have perfectly random samples of a large population. But, if we are willing to make the necessary assumptions, we find that in many, many instances the assumptions are justified in terms of practical considerations. Much has been said against the samples used in behavioral research . . . but generalizations based upon samples in which care has been taken to eliminate bias and which are then treated as if they were random samples from larger populations have been found to be sound and useful. The fact is that no one has ever studied the correlation between college grades and tests of academic aptitude in a strickly random sample of college students from the population of all college students. Yet generalizations have held up that have been made on the basis of available correlation coefficients derived from samples and tests of significance have been applied to these coefficients as though they were derived from random samples.[14]

The writer makes the assumption that the study sample group is a random group of first year mathematical students at Central Washington College of Education.

II. THE CRITERIA OF ACHIEVEMENT: MATHEMATICS CLASSES

The criteria of achievement for the present study is defined in terms of the numerical grades received in the mathematics classes offered primarily during the freshman year. In order to eliminate the pooling of instructors' grades, the writer kept each instructor and each mathematics class separate. To eliminate the use of the instructors' names, the

---

[14]Allen L. Edwards, Statistical Analysis for Students in Psychology and Education (New York: Rinehart and Company, Inc., 1953), pp. 285-286.

writer chose to use the letters A, B, and C to distinguish between the three instructors at this institution.

Description of Courses

In order to facilitate the use of this study, each class used is described and any new additions or changes are noted. The numbers in parentheses are the new numbers which went into effect for the 1955-1956 school year.

> Mathematics 2 (145). Fundamentals of Algebra. Designed for students having a deficiency in High School Algebra, or needing algebra review, as a course preliminary to Introduction to Mathematics 49. Five credits.
>
> Mathematics 3 (147). Geometry. A course for students having a deficiency in High School Geometry, who contemplate enrolling later in courses more advanced than college algebra. Five credits.
>
> Mathematics 49. Introduction to College Algebra. A short course in algebra for pre-professional students who wish to combine algebra with trigonometry for five hours of mathematics only, or for those who feel the need of preliminary work before taking College Algebra 50 below. Two credits.
>
> Mathematics 50 (161). College Algebra. Functions and graphs, quadratic equations, polynomials, logarithms, exponentials progressions. Prerequisites, three semesters of High School Algebra, or Mathematics 49. Five credits.
>
> Mathematics 51 (165). Trigonometry. Functions of acute angles, solution of right and oblique triangles, functions of any angle, identities, trigonometric equations. Prerequisites, two semesters of high school algebra and either high school geometry or Mathematics 3. Three credits.
>
> Mathematics 52 (175). Analytic Geometry and Calculus. Graphic representation, the straight line, graphs of the circle, eclipse, parabola, hyperbola, a study of rates, differentiations, and integration. Prerequisite, Mathematics 50 and 51. Five credits.
>
> Mathematics 54, 55, 56 (171, 172, 173). Mathematical Analysis. This is a synthetic course which integrates the conventional content of College Algebra, Trigonometry, and Analytic Geometry in a study of functions and graphs, rates, maxima and minima, logarithms, exponential functions and the elements of differential and integral calculus. Recommended for pre-engineers and for physical science majors. Prerequisites, two or preferably three semesters of high school algebra, and either high school geometry or Mathematics 3. Five credits each quarter.[15]

---

[15]The Quarterly of the Central Washington College of Education, Ellensburg,,Washington, 46:174-175, July, 1954.

For the 1955-1956 school year, Mathematics 49 has been deleted. Mathematics 50 (161) is now College Algebra I.

> 5 credits. Prerequisites, three semesters of high school algebra, or Mathematics 145 (2). A review of fundamentals, quadratic equations, logarithms, exponentials, functions and graphs.[16]

Mathematics 57 (162) was added during the 1954-1955 school year.

> College Algebra II. 2 credits. Prerequisite, Mathematics 161 (50). Complex numbers, theory of equations, determinents, series.[17]

The prerequisites for Mathematics 54, 55, 56 (171, 172, 173) have changed from two or preferably three semesters of high school algebra and either high school geometry or Mathematics 3 to " . . . three semesters of high school algebra and high school trigonometry."[18] Mathematics 52's (175) prerequisites have changed from Mathematics 50 and 51 to " . . . Mathematics 162 and 165 (57 and 51), or Mathematics 172 (55)."[19]

Grading in Mathematics Classes

The study sample was taken directly from the instructors' grade books. All three instructors used the number system of grading, i.e., for each test the number correct was placed in the grade book and the average of the scores was then converted into letter grades. In some classes the daily work was also averaged in, but because not all classes had the daily work entered into the grade book, the writer took only the test grades plus double the semester test grade, since it was a two hour test, and averaged all tests for the quarter grade. All three instructors use approximately the same grading procedure, 90-100 percent correct is

---

[16] The Quarterly of the Central Washington College of Education, Ellensburg, Washington, 47:190, July, 1955.

[17] Ibid., p. 191 [18] Ibid. [19] Ibid.

an A, 80-90 is a B, 60-80 is a C, 50-60 is a D, and below 50 is an F. The C and the D grades continue down in some instances but in essence, they are as stated.

III. THE PREDICTIVE DEVICE: THE ACE PSYCHOLOGICAL EXAMINATION

In the long continued use of the ACE by colleges and universities, the test has been administered mainly for the purpose of student guidance. It was with this in mind that this study was made. A brief description of the test and previous studies based on this test are discussed.

Description of the Test

The ACE test is an instrument designed to measure aptitude for college study. Thurstone and Thurstone describe its function as:

> It is not what is commonly referred to as an intelligence test, but rather a test of certain intellectual abilities that have been shown to be closely related to scholastic success.[20]

Two different editions of the test, the 1947 edition and the 1952 edition, were taken by the study sample group. The 1947 edition's raw scores were used in the mathematical computations, converting the 1952 edition's raw scores according to the Table of Equivalents given in Appendix A. Thurstone and Thurstone justify the procedure used in this study mentioning:

> Beginning with the 1940 edition of the Psychological Examination, the separate test questions have been subjected to an analysis on the basis of difficulty. The items have been selected so as to make total scores in the successive editions directly comparable.[21]

---

[20] L. L. Thurstone and Thelma Gwinn Thurstone, American Council on Education: Psychological Examination for College Freshmen: Norms Bulletin (California: Educational Testing Service, 1952), Forward.

[21] Ibid., p. 3.

The Norms Bulletin for the ACE has provided separate norms for four year colleges, junior colleges, and teachers' colleges. Also included is a table of norms for all colleges reporting in scores.[22] Crawford and Burnham state:

> These data are extensive, but the institutions from which they derive are so variant in nature and widely different in educational standards that national norms based upon such a motley congregation seem difficult to interpret meaningfully for their respective separate groups.[23]

Percentile norms are ranked scores placed on a scale 100 rank point long. The highest score value is at or above the 99th percentile. rank and the lowest score is at or below the lst percentile rank. The percentile rank of a given score shows the proportion of scores that are equal to or lower than the given score in the general population. Because percentile scores give a distorted picture of the units, especially at the extremes of the distribution, the raw scores were used in all computations in the present study. A further description is provided by Thurstone and Thurstone:

> The examination consists of six tests that have been used for several years. The order of the tests has been arranged to alternate linguistic and quantitative tests because of the fatigue element. All of the tests have been included in several test experiments with factorial analyses to determine the primary mental abilities. The studies have justified the grouping of the six tests into two general classes, Quantitative Tests and Linguistic Tests . . . . It is not recommended that the six separate test scores be used for counseling, but there seems to be justification for using the two principal subscores as well as the total or gross score in this manner.[24]

---

[22] Ibid.

[23] Albert B. Crawford and Paul S. Burnham, Forecasting College Achievement (New Haven: Yale University Press, 1946), p. 91.

[24] L. L. Thurstone and T. G. Thurstone, American Council on Education: Psychological Examination for College Freshmen: Manual of Instructions (California: Educational Testing Service, 1952), p. 2.

The Q Score. The three tests that make up the quantitative section or Q score are the Arithmetic Reasoning Test, the Number Series Test, and the Figure Analogies Test. As described by Guilford:

> The "quantitative" part is a conglomerate factorially. Besides measuring numerical facility, this part also probably measures three kinds of reasoning as well as other factors to a small degree. It probably would select students with good reasoning abilities, but validity studies might well fail to show this fact because of the manner in which achievement is assessed . . . The number-series test could be dispersed within the "quantitative" part, since it probably adds nothing unique in the way of factors.[25]

The L Score. The L score, linguistic score, is the accumulated scores on the Same-Opposite Test, the Completion Test, and the Verbal Analogies Test. Guilford[26] states that the linguistic part of the examination is heavily saturated with verbal-factor variance and that the vocabulary test would suffice for this score. Commins remarks that

> . . . some items in the completion test . . . seem to plumb one's familiarity with relatively uncommon words . . . while other items seem aimed more at the understanding of the object whose name is sought.[27]

The T Score. The T or total score is merely the sum of the Q score and the L score. Most of the studies on the ACE have been made using only this total score, however, in recent years, the subscores have gained increasing significance in prediction.

Previous Studies

Many studies have been reported on the reliability and predictability of the ACE scores. The consensus of opinion seems to be that the

---

[25]J. P. Guilford, In Buro's The Third Mental Measurement Yearbook (New Brunswick: Rutgers University Press, 1949), p. 218.

[26]Ibid., pp.217-218.

[27]W. D. Commins, In Buro's The Third Mental Measurement Yearbook (New Brunswick: Rutgers University Press, 1949), p. 217.

ACE remains one of the best single predictors of college achievement but in many cases it cannot be heavily relied upon alone. Such items as high school grade point averages and college freshman grade point averages should also be taken into consideration for predicting college success.

Several reliability studies have been published on the ACE. Willett[28] reports on one such study in the state of Illinois. The University of Illinois and other higher institutions of the state of Illinois, in cooperation with the high schools, give tests to seniors and/or juniors at a specified time on a specified day in the spring. The university scores the tests and sends back the percentile rank of each individual on each test as compared with all state pupils who had taken the test in his class. By mistake the tests sent to one high school in 1944 were identical to the ones sent out in 1943. One of these tests was the ACE. "Almost all raised their rank ten percentile points on the "L" score. Similar changes but to a much lesser degree occurred on the "Q" test."[29] Willett explained the change as follows:

> The deduction which seems to best explain the great variability shown in the data presented is that individuals do vary greatly in their reactions to similar situations at different times. The further deduction is that results on a single testing period is probably inadequate. In many cases such data will need to be substantiated by other information of a corroborating sort if individuals are to be reliably rated.[30]

In the spring of 1948 students at Iowa State Teachers College who were classified as sophomores repeated part of the entrance examination, one test being the ACE. Silvey noted that mean scores on the second test

---

[28]G. W. Willett, "Reliability of Test Scores on Seven Tests," Journal of Educational Research, 43:293-299, December, 1949.

[29]Ibid., pp. 294-295 [30]Ibid., p. 298

were considerably higher than the first test indicating a substantial gain. The conclusion drawn was that the gain should be interpretated in terms of potentials for mental growth and development rather than an increase in brightness.[31]

The results of Shuey's study on improvements in scores on the ACE from freshmen to senior year are that there was:

> . . . relatively greater improvement by score and percentile rank among the lower than among the higher scoring students, . . . and evidence lends support to the view that mental growth continues during the college years . . . The evidence suppests that college training stimulates mental growth such as is measured by the ACE.[32]

In a report of the afternoon session on Mental Testing at the Fourteenth Annual Meeting of the Midwestern Psychological Association, Thomson reported that:

> Retest results for the A.C.E. Psychological Examination gave a significant difference in the gross score mean, and a very wide range of individual changes in gross scores. No significant difference was found when the two sets of scores were correlated with college grades. Individual raw score changes correlated very slightly with low scores.[33]

Samenfeld[34] reported that the Association of Minnesota Colleges conduct an annual testing program for high school seniors for the purpose

---

[31]Herbert M. Silvey, "Changes in Test Scores After Two Years in College," Educational and Psychological Measurements, 11:494-502, Autumn, 1951.

[32]Audrey M. Shuey, "Improvement in Scores on the American Council Psychological Examination from Freshmen to Senior Year," Journal of Educational Research, 39:425, 1948.

[33]William A. Thomson, "Retest Results on the A.C.E. Psychological Examination," Psychological Bulletin, 36:636, 1939.

[34]Herbert W. Samenfeld, "Predicting College Achievement," Journal of Higher Education, 24:432-433, November, 1953.

of providing high school advisors with basic data for selecting and encouraging capable students to enroll in college. One of the tests used was the ACE. One year 9th graders were given the ACE Psychological Examination for College Freshmen and four years later they were given the same test while in the 12th grade. Zero-order correlations were run and were found significant at the one percent level of confidence. Samenfeld concluded that the ACE could be used in the 9th grade for predicting college achievement with as much confidence as it is now used in the senior year of high school. Mere significance of stability of rank does not sufficiently justify its confident use for individual prediction. Correlations between ACE scores in the ninth grade and college success would need to be as high as ACE acores in the twelvth grade with college success before using ninth-grade scores with confidence.

In a study by Thomann[35] correlation coefficients for 591 boys and girls who were examined in high school and later in college and who completed two semesters of work were complied. Correlations between the two total ACE test scores ranged from .673 to .836 for various groups and was .713 for the total group. The correlation between college grades and the ACE high school examination was .40 while the correlation between the college grades and the college ACE examination was .44. It was concluded that the two tests were of essentially equal value, and that they predict college success better than rank in the high school group.

---

[35]Donald F. Thomann, "Relationship Between the High School and College Editions of the American Council on Education Psychological Examination and Their Relative Value in Predicting College Achievement," Psychological Abstracts, 22:4631, 1948.

Hoerres and O'Dea,[36] in their study to determine the relative validity of the Q, L, and T ACE scores in the prediction of final marks earned in specific courses at the University of Wisconsin, limited their computations to the college freshman. They ran Pearson product-moment correlations and obtained the following paraphrased results for mathematics:

Q score and mathematics equal to .29, significant at the 1% level of confidence.
L score and mathematics equal to .19, significant at the 1% level of confidence.
T score and mathematics equal to .25, significant at neither the 1% or the 5% level of confidence.

The findings suggest that the ACE scores were significant only in terms of group predictiveness and that they appear unadvisable to use in isolation as a predictive device for individual counseling concerning mathematics courses.

In a study by Brown in the Liberal Arts Division of the Long Beach City (Junior) College, the courses were divided into those that were primarily quantitative (mathematics and science) and those that were primarily linguistic (English, social studies, and languages). The following is a summary of Brown's results:

ACE Score	Grade Point Averages		
	Quantitative	Linguistic	Total
Q	.33	.18	.34
L	.30	.54	.32
T	.40	.44	.40[37]

---

[36]Mary A. Hoerres and J. David O'Dea, "Predictive Value of the A.C.E.," Journal of Higher Education, 25:97, February, 1954.

[37]Hugh S. Brown, "Differential Prediction by the A. C. E.," Journal of Education Research, 44:117, October, 1950.

For the quantitative subjects, both the Q and L correlations are too low to have much predictive value for use in individual counseling and Brown clarified that:

> In general there appears to be some basis for the conclusion that as a group the higher the scores the lower the possibility of failing to maintain a C average but to set critical scores on which to advise an individual to enter or not to enter specific curricula does not appear possible in this institution.[38]

Wallace conducted a study at the University of Michigan where the ACE has been given to freshmen students each year. Wallace calls attention to the fact that the correlations are highest in succeeding levels and that the ACE still remains the best single predictor of academic success in higher education. The correlation between the ACE and different mathematics classes are as follows:

	Q	L	T
Math. (Elem. Algebra and Trig.)	.207	.159	.224
Math. (College Algebra and Trig.)	.227	.186	.219
Math. (Algebra and Analytic Geometry)	.393	.182	.331
Average Grade Freshman Year	.292	.370	.410[39]

At the Galesburg Division of the University of Illinois each September the incoming freshmen and new sophomore students are given a battery of tests for use in counseling and guidance as well as for placement in various courses such as mathematics. The independent variables used in the study described were total score and the mathematical comprehension score on the Cooperative General Achievement Test, Test III, (CGA) the T, Q, and L scores on the ACE, and the total score on the Van Wagenen and Dvorak Diagnostic Examination of silent Reading Abilities. The rank position in high school was also used. The criteria of success selected,

---

[38] Ibid., pp. 119-120.

[39] W. L. Wallace, "Differential Predictive Value of the ACE Psychological Examination," School and Society, 70:24, July 9, 1949.

was the average grade in mathematics. The summary of Bromley and Carter's results is as follows:

Variate	r
1. T score on Cooperative General Achievement test, Test III.	.35
2. Mathematical Comprehension and Interpretation score on Cooperative General Achievement Test, Test III.	.32
3. T score on the ACE.	.24
4. Q score on the ACE.	.28
5. L score on the ACE.	.16
6. T score on Van Wagenen and Dvorak Diagnostic Examination of Silent Reading Abilities	.11
7. Rank in High School	.40[40]

The authors combined the total score on the CGA, the Q score on the ACE, and the rank of the student in his high school graduating class for the prediction equation. It is interesting to note that the rank scores of the students has a higher correlation coefficient in this instance and is a better predictor.[41] This is in disagreement with Thomann's study reported previously.

Ralph Berdie, Paul Dressel, and Paul Kelso had a study group of entering freshmen from 13 participating colleges. The reasoning behind the study was that the Q and L scores on the ACE should be related to subjects commonly studied in the freshman year and the total grade point average to justify the use of the ACE in the examination program. The means of the 13 colleges and universities ran from:

a. 38.2 with σ of 11.1 to 50.8 with σ of 9.06 for Q and men
   33.1 with σ of 8.9 to 47.84 with σ of 7.84 for Q and women
b. 57.47 with σ of 14.18 to 71.78 with σ of 15.18 for L and men
   59.27 with σ of 17.49 to 94.1 with σ of 13.33 for L and women

---

[40]Ann Bromley and Gerald C. Carter, "Predictability of Success in Mathematics," Journal of Educational Research, 44:149, October, 1950.

[41]Ibid., p. 150

c. 82.9 with σ of 25.6 to 119.62 with σ of 17.15 for T and Men
89.0 with σ of 21.2 to 121 with σ 19.52 for T and women.[42]

The T score correlated with total GPA with r's ranging from .25 to .66 and coefficient of correlations ranged from -.03 to .61 when correlated with mathematics grades. The Q score and grade average correlations ranged from .15 to .55 and with mathematics grades from .11 to .58. Correlations varied from .18 to .65 between the L score and total grade point average and from -.16 to .64 between mathematics grades and the L score.

> With but one exception the correlations of the L score with the total grade ran appreciably higher than the correlations of Q scores with grades.[43]

The study shows the extreme variability associated with students, sex, courses, and teaching and examination methods, suggesting that inconsistancy in any of these might markedly change obtained correlations with the ACE.[44]

At the Purdue University, the Q, L, and T scores on the ACE did not prove as closely related to the first semester grade point average as did the Purdue Placement Test in English, the Purdue Physical Science Test, and the Purdue Mathematics Training Test.[45] A possible explanation for this could be that the Purdue tests were especially designed with their requirements in mind.

---

[42]Ralph Berdie, Paul Dressel, and Paul Kelso, "Relative Validity of the Q and L Scores of the ACE Psychological Examination," Educational and Psychological Measurements, 11:805, 1951.

[43]Ibid., p. 808. [44]Ibid., pp. 810-811.

[45]H. H. Remmers, D. W. Elliott, and N. L. Gage, "Curricular Differences in Predicting Scholastic Achievement: Applications to Counseling," Journal of Educational Psychology, 40:385-394, 1949.

Bolton[46] comes to the conclusion that for women at Georgia State College for Women the total grade average of the freshman year is a better predictive device for subsequent college grades than the ACE, however, the T score on the ACE predicts achievement better than either the Q or L scores. It is Bolton's contention that no freshman should be officially excluded from college because of low standards of scholarship until the end of the freshman year.

The conclusion drawn by Frederiksen and Schrader[47] was that a weighted composite of the ACE test score and the high school standings provided a useful prediction of freshman grade average. The median correlation of the ACE with first year college grades was .47 while the median correlation using high school standing was .57.

Barrett[48] undertook a study on the differential value of the ACE for predicting achievement in mathematics at Hunter College. The ACE test scores were correlated with grades in trigonometry, college algebra, and analytic geometry. The results indicate that the quantitative scores did not consistently predict achievement in mathematics courses significantly better than linguistic scores. The results are as follows:

---

[46]Euri Belle Bolton, "Predictive Value for Academic Achievement of the ACE Psychological Examination Scores," Peabody Journal of Education, 29:345-360, May , 1952.

[47]Norman O. Frederiksen and W. B. Schrader, "A. C. E. Psychological Examination and High School Standing as Predictors of College Success," Journal of Applied Psychology, 36:261-265, August, 1952.

[48]Dorothy M. Barrett, "Differential Value of the Q and L Scores on the ACE Psychological Examination for Predicting Achievement in College Mathematics," Journal of Psychology, 33:205-207, 1952.

	Q	L	T
Trigonometry			
'43 Edition	.255 ± .04	.015 ± .04	.023 ± .04
'48 Edition	.265 ± .06	.282 ± .06	.288 ± .06
College Algebra			
'43 Edition	.280 ± .04	.095 ± .04	.140 ± .04
'48 Edition	.311 ± .06	.194 ± .06	.288 ± .06
Analytic Geometry			
'43 Edition	.200 ± .06	.170 ± .06	.230 ± .04
'48 Edition	.297 ± .07	.269 ± .07	.377 ± .06

In a study to determine if the study of mathematics in college affects the score on the quantitative test, Barnes reports that a group of 75 University of Illinois students who had completed the freshman and sophomore years without taking a course in mathematics were compared with a group of 40 mathematics students who had also completed two years of college. The average semester hours of mathematics taken was eight. The conclusion was that in this instance, the study of mathematics did not increase the quantitative score. He also describes mathematics students by saying:

> It is interesting to note that the students choosing mathematics were superior in ability as measured by the total score on the ACE test to those not taking mathematics. The mean of the gross scores of the mathematics group was 121.45; that of the non-mathematic group was 100.00.[49]

A similar observation was made in the study group for the present study.

IV. TREATMENT OF THE DATA

The raw scores on the Q, L, and T sections of the ACE test were used as the independent variables. These scores were obtained for each student from the tests filed in the Office of Personnel and Placement at Central Washington College of Education. As described earlier, the 1947

---

[49] Melvin W. Barnes, "The Relationship of the Study of Mathematics to Q-Scores and the ACE Psychological Examination," School Science and Mathematics, 43:582, June, 1943.

edition's raw scores were used in the computations, changing the 1952 edition's raw scores according to the equivalent table. The independent variable chosen was the numerical grade in the different mathematics classes. These scores were obtained directly from the instructors' grade books since only the letter grades are on the transcripts. The average of the tests given during the quarter was derived by combining each student's numerical test scores with double the quarter final, since it was a two hour test, and dividing by the number of tests given during the quarter.

Following the procedure described by Edwards,[50] Pearson product-moment coefficients or correlation and standard errors of r using $\frac{1 - r^2}{\sqrt{N - 1}}$ were computed for each instructor's class and between different instructors and their classes. As in most educational and psychological research using Pearson's r the 5% level of significance was set as the minimum acceptable for this study. This, at a simple level of explanation, means in essence that if the correlation coefficients obtained are larger than the coefficients of correlation necessary, as stated in Table of Values of the Correlation Coefficient for Different Levels of Significance in Edwards, the obtained r would occur due to random sampling less than five times in a hundred samplings.

An example of the procedures described above can be found in Appendix B. For the example class the writer has also developed the regression equation. This regression equation can be used as a sample in case faculty members who do educational counseling at this institution wish to use the results of this study in the most effective manner.

---

[50]Allen L. Edwards, Statistical Methods for the Behavioral Sciences, (New York: Rinehart and Company, Inc., 1955), pp. 142 ff.

CHAPTER III

THE RESULTS AND IMPLICATIONS OF THE STUDY

As stated in Chapter I, the main purpose of this study was to determine the relationship between grades in each mathematics class offered during the freshman year and the raw scores on the Q, L, and T sections of the ACE Psychological Examination for College Freshmen.

The summary of the data is presented in Table III. Seventeen out of thirty-three correlations were found to be significant above the 5% level of confidence. Ten of these seventeen correlations were found to be significant at or beyond the 1% level. In this institution, the hypothesis that the Q score is more closely related to the quantitative subjects, in this case mathematics, does not seem to be substantiated. Any one section of the test seems as closely related to the grade average as the remaining two sections.

I. RESULTS

The results are described class by class.

Mathematics 2 (145): Fundamentals of Algebra

Correlation coefficients ranged from .23 $\pm$ .20 (the second digits are standard error of r) to .45 $\pm$ .09 for the two sections of the class. For instructor A the correlation between the Q score and grades was .25 $\pm$ .20, between the L score and grades was .23 $\pm$ .20, and between the T score and grades it was .31 $\pm$ .19. None of these correlations were found to be significant.

Instructor B's class correlations were .45 $\pm$ .09 with Q, .28 $\pm$ .10 with L, and .45 $\pm$ .09 with T. All three of these correlations were found

TABLE III
COEFFICIENTS OF CORRELATIONS BETWEEN EACH INSTRUCTOR'S CLASS AND THE Q, L, AND T SCORE ON THE ACE

Instructor	Class	Number	Q Score	L Score	T Score
A	2	24	.25 ± .20	.23 ± .20	.31 ± .19
A	49	22	.46 ± .17*	.30 ± .20	.35 ± .19
A	50	29	.27 ± .11*	.11 ± .12	.24 ± .11
B	2	83	.45 ± .09**	.28 ± .10**	.45 ± .09**
B	49	30	.24 ± .18	.25 ± .17	.28 ± .17
B	50	35	.02 ± .20	.52 ± .15**	.40 ± .17*
B	51	48[2]	.20 ± .14	.19 ± .14	.24 ± .14
C	50	52[2]	.51 ± .11**	.17 ± .14	.41 ± .12**
C	51	58[2]	.45 ± .11**	.46 ± .10**	.64 ± .08**
C	52	71	.42 ± .10**	.08 ± .12	.25 ± .11*
C	54	14	.47 ± .22	.17 ± .27	.28 ± .26
C	55	10	.22 ± .32	-.31 ± .30	-.20 ± .32
C	57	35[2]	.35 ± .15*	.41 ± .14*	.40 ± .14*

1. All Positive except where indicated
2. One additional student for the T score whose subtests were not reported

* 5% level of significance
** 1% level of significance

to be significant above the 1% level of confidence. This class was used as the sample class in Appendix B and the derivation of regression equations is shown.

The average r (using Fisher's z' transformation) for the Q score is .35 which is significant above the 1% level of confidence. The average r for the L score is .26 and for the T score is .39, both significant above the 1% level of confidence.

Mathematics 49: Introduction to College Algebra

Instructor A's class correlation with the Q raw score .46 ± .17. This was the only correlation that was found significant above the 5% level of confidence for this course. The correlations obtained between the L score and class grades and the T scores and class grades are .30 ± .20 and .35 ± .19 respectively.

The coefficients of correlation for Instructor B's class grades are the Q, L, and T raw scores are .24 ± .18, .25 ± .17 and .28 ± .17 respectively.

The average r for the Q score is .36 which is significant above the 1% level of confidence. The average r for the L score is .28 and for the T score is .32, both significant above the 5% level of confidence.

Mathematics 50 (161): College Algebra

All three instructors had sections of College Algebra. Five out of the nine correlations were found significant beyond the 5% level of confidence. Correlations ranged from .02 to .51 between the Q score and class grades, from .11 to .52 between L score and class grade, and from .24 to .41 between the T score and class grades. Correlations between Instructor A's section and the Q, L, and T raw scores are .27 ± .11,

.11 ± .12 and .24 ± .11. In this instance, only the correlation using Q was found to be significant above the 5% level of confidence.

The only instance in which both the L and the T r's were found to be significant above the Q was in Instructor B's section of Mathematics 50. A correlation of .02 ± .20 was found between the Q score and the grade average while correlations of .52 ± .15 and .40 ± .17 were found between the L and T scores respectively. The correlation using L is significant above the 1% level of confidence and the T correlation is significant above the 5% level of confidence.

Both the Q correlation of .51 ± .11 and the T correlation of .41 ± .12 were found significant above the 1% level of confidence for Instructor C's class. The correlation between the L score on the ACE and the class grades were found to be .17 ± .14.

The average r for the T score is .50, for the Q score is .41, and for the L score is .41. All are significant above the 1% level of confidence.

Mathematics 51 (165): Trigonometry

Three out of the six correlations computed for the two sections of Trigonometry were found to be significant above the 1% level of confidence. These were the correlations computed between Instructor C's Trigonometry class and the Q, L, and T scores on the ACE. These correlations are .45 ± .11 with the Q score, .46 ± .10 with the L score, and .64 ± .08 with the T score.

Correlations between the three scores on the ACE and Instructor B's class are .20 ± .14, .19 ± .14 and .24 ± .14. The average r for the T score is .47, for the Q score is .33 and for the L score is .33. All

are significant above the 1% level of confidence.

Mathematics 52 (175): Analytic Geometry and Calculus

Only one section of the Analytic Geometry and Calculus was taught during the two year period. The correlation between the Q score and the grade was .42 ± .10 and it was found significant above the 1% level of confidence. A correlation of .09 ± .12 and a correlation of .25 ± .11 were found between the L and T scores and class grades respectively. The correlations were found significant above the 5% level of confidence.

Mathematics 54 (171): Mathematical Analysis

The one section of Mathematics was taught by Instructor C. None of the correlations were found significant above the 5% level of confidence. The correlations are .47 ± .22 between the Q score and class grade, .17 ± .27 between the L score and class grade, and .28 ± .26 between the T score and class grade.

Mathematics 55 (172): Mathematical Analysis

Only ten students enrolled in Mathematics 55. Insignificant negative correlations were obtained for both the L and the T scores. These are the only negative correlations obtained in the study. They are -.31 ± .30 and -.20 ± .32 for the L and T scores respectively. A positive correlation of .22 ± .32 was found to exist between the Q score and the class grade.

Mathematics 57 (162): College Algebra II

Thirty-five students enrolled in College Algebra II during the one year it was offered. Positive correlations of .35 ± .15, .41 ± .14, and .40 ± .14 were found to exist between the class grade and the Q, L, and T raw scores respectively. All were found significant above the 5% level

of confidence.

Correlations Between Classes

Correlations ranging from .62 to .84 were found to exist between any two mathematics classes. A summary of the correlations is given in Table IV. All correlations were found to be significant above the 1% level of confidence. Regression equations for each of these paired classes are in Appendix C of this report.

II. IMPLICATIONS

The results show that in general there is a positive correlation of moderate magnitude between the Q, L, and T raw scores on the American Council on Education Psychological Examination and mathematical success as defined in this study. The value of these correlations for individual prediction purposes at Central Washington College of Education is questionable.

The correlations obtained between the different mathematics classes are all moderately high and are all significant above the 1% level of confidence. The results seem to indicate that the grade received in one mathematics class is a better predictor of success in other mathematics classes than the ACE Psychological Examination. The combination of the ACE test scores and the grades received in the mathematics courses forming multiple regression equations would seem to be a highly effective predictive device for individual prediction of subsequent mathematics grades.

TABLE IV

COEFFICIENTS OF CORRELATION
OBTAINED BETWEEN DIFFERENT
MATHEMATICS CLASSES

CLASS	Number	r
1. A-50 and B-51	17	.77 ± .102**
2. A-50 and C-51	16	.72 ± .124**
3. A-50 and C-52	16	.67 ± .142**
4. A-50 and C-57	16	.69 ± .135**
5. B-2 and B-50	16	.83 ± .08**
6. B-2 and B-51	17	.625 ± .152**
7. B-49 and B-51	15	.80 ± .096**
8. C-50 and C-51	29	.84 ± .056**
9. C-50 and C-52	32	.65 ± .104**
10. C-50 and C-57	20	.68 ± .123**
11. C-51 and C-52	39	.79 ± .061**
12. C-51 and C-57	31	.78 ± .071**
13. C-52 and C-57	28	.80 ± .069**

**At the 1% level of significance

CHAPTER IV

THE SUMMARY AND CONCLUSION

The main purpose of this study was to determine the relationship between the American Council on Education Psychological Examination for College Freshmen and individual mathematics classes at Central Washington College of Education for use in predicting success in subsequent mathematics courses. A second purpose developed during the study was to determine the relationship between the mathematics grades of the different courses.

I. SUMMARY

The independent variable chosen was the American Council on Education Psychological Examination. The dependent variables used were the different mathematics courses offered primarily during the freshman year. The students taking the designated mathematics courses during the 1953-1954 and the 1954-1955 school year were chosen as the study sample. Two editions of the ACE, the 1947 edition and the 1952 edition, were taken by the sample study group as part of the entrance examinations given to freshmen and transfer students each year. Raw scores on the Q, L, and T sections of the ACE were obtained from the original tests kept in the files in the Office of Personnel and Placement at Central Washington College of Education. Raw scores on the 1952 edition's test were converted to equivalent 1947 raw scores according to the table of equivalents found in the Appendix A of this report. The 1947 edition's raw scores were used in the computations. The numerical grades obtained in each class were derived by adding the numerical test grades to double the score on the final test and dividing the sum by the number of tests given during the quarter.

The study sample group was composed of 294 students registered for the classes. Out of the 294 students, fourteen withdrew from the classes, two students had no records available, two students were classified as special students and therefore did not take the ACE, and one student received no grade, leaving a total of 275 students. The range of the total percentile scores, as determined from the all college norms, for the fourteen students that withdrew from the classes was eighty-five percentile points, from two to eighty-seven, with a median at the twenth centile. The study sample group ranged from a minus one to a ninty-nine plus with a median at the forty-sixth centile. The study sample group was found higher than the group that withdrew from the classes; hence it is reasonable to state that the correlations obtained in this study are slightly attenuated due to the restriction of the range.

The study sample group was found to be above the CWCE population during the two year period as measured by the total score on the ACE and above the CWCE population that had taken the test. This does not mean that the sample group is not a true sample of the students who enroll in mathematics courses but may point out that the mathematics students average higher total scores than the students who do not enroll for mathematics courses.

Pearson product-moment correlations were computed between the Q, L, and T scores on the ACE and the various mathematics classes as well as each instructor's section of the mathematics classes. Correlations were also computed between each of the individual mathematics classes. Regression coefficients and equations were computed for the prediction of individual success from knowledge of an individual's numerical grade

in certain mathematics classes. These equations can be found in the Appendix C of this report.

Seventeen out of the thirty-three correlations computed between the Q, L, and T scores on the ACE and the mathematics classes were found to be significant above the 5% confidence level. Ten of these reached above the 1% level. Correlations between the Q raw score and the classes ranged from $.02 \pm .20$ to $.51 \pm .11$. Correlations ranging from $-.31 \pm .30$ to $.52 \pm .15$ were obtained between the L raw score and the class grades while for T score and the class grades correlations ranged from $-.20 \pm .32$ to $.64 \pm .08$. There seemed to be no significant difference between the Q, L, and T scores in their ability to predict success in mathematics. This is in line with findings on some of the colleges studying the same problem.

The correlations between any given mathematics class and a subsequent class ranged from $.62 \pm .15$ to $.84 \pm .06$. All of these thirteen correlations were significant above the 1% level of confidence.

II. CONCLUSIONS

At this institution numerical grades in any mathematics class are better predictors of mathematics success in later mathematics classes than are the ACE raw scores. The T and the L scores on the ACE can be used with the same effectiveness as the Q score for predicting success in mathematics. The results of the study seem to indicate that while there is a positive correlation between the total and part scores on the ACE and mathematical courses at the institution, the correlations are of such small magnitude that little use can be made of these scores alone for individual predictions. Group predictions could feasibly be made, however.

Although in general positive correlations were obtained, there is no indication that the scores predict better for one class than another or for one instructor over another. Significant correlations were obtained for all courses except Mathematics 54 and 55 (Mathematical Analysis). The small number of students enrolled in these classes, making for a larger standard error, could very well be the reason for this.

The correlation coefficients between the numerical grades for the different classes are significant and sufficiently high for use in individual predictions of subsequent mathematics courses. One limitation of this study is the small number of paired observations on which the correlations are based. Despite the small sample numerous r's are significant and when significant this is highly indicative of what will be found in very similar situations. The reader should, however, take this limitation into consideration when using the results of this study.

The study points to the need for further correlation studies on this campus. Both zero-order and multiple correlation are necessary for greatest accuracy in prediction. Because the coefficients of correlations are so high between the different mathematics courses, additional studies correlating different subjects with one another would probably be of considerable benefit to the faculty members serving as educational counselors.

Further evaluation of the educational objectives at this institution should be attempted so that additional studies on prediction of success in college can be of greater value. It is only when success in college has been clearly defined in terms of the educational objectives and the criteria of evaluating these objectives have been established that prediction studies will best predict the success of an individual.

BIBLIOGRAPHY

BOOKS

Anastasi, Anne. Psychological Testing. New York: MacMillan Company, 1955.

Commins, W. D. In Buro's The Third Mental Measurement Yearbook. New Brunswick: Rutgers University Press, 1949.

Crawford, Alfred B., and Paul S. Burnham. Forecasting College Achievement. New Haven: Yale University Press, 1946.

Edwards, Allen L. Statistical Analysis for Students in Psychology and Education. New York: Rinehart and Company, Inc., 1953.

Edwards, Allen L. Statistical Methods for the Behavioral Sciences. New York: Rinehart and Company, Inc., 1955.

Guilford, J. P. Fundamental Statistics in Psychology and Education. New York: McGraw Hill Book Company, Inc., 1942.

Guilford, J. P. In Buro's The Third Mental Measurement Yearbook. New Brunswick: Rutgers University Press, 1949.

The Quarterly of the Central Washington College of Education. Ellensburg, Washington, 1954.

Thurstone, L. L., and Thelma Gwinn Thurstone. American Council on Education: Psychological Examination for College Freshmen: Manual of Instruction. California: Education Testing Service, 1952.

Thurstone, L. L., and Thelma Gwinn Thurstone. American Council on Education: Psychological Examination for College Freshmen: Norms Bulletin. California: Educational Testing Service, 1952.

PERIODICALS

Barnes, Melvin W. "The Relationship of the Study of Mathematics to Q-Scores and the ACE Psychological Examination," School Science and Mathematics, 43:581-582, June, 1943.

Barrett, Dorothy M. "Differential Value of the Q and L Scores on the ACE Psychological Examination for Predicting Achievement in College Mathematics," Journal of Psychology, 33:205-207, 1952.

Berdie, Ralph, Paul Dressel, and Paul Kelso. "Relative Validity of the Q and L Scores on the ACE Psychological Examination," Educational and Psychological Measurements, 11:803-812, 1949.

Bolton, Euri Belle. "Predictive Value for Academic Achievement of the ACE Psychological Examination Scores," Peabody Journal of Education. 29:345-360, 1952.

Bromley, Ann, and Gerald C. Carter. "Predictability of Success in Mathematics," Journal of Educational Research, 44:148-150, October, 1950.

Brown, Hugh S. "Differential Prediction by the A.C.E.," Journal of Educational Research, 44:116-121, October, 1950.

Frederikson, Norman O., and W. B. Schrader. "A.C.E. Psychological Examination and High School Standing as Predictors of College Success," Journal of Applied Psychology, 36:261-265, August, 1952.

Fusfeld, Irving S. "On the ACE Psychological Examination," School and Society, 70:117-118, August 20, 1949.

Hoerres, Mary A., and J. David O'Dea. "Predictive Value of the A.C.E.," Journal of Higher Education, 25:97, February, 1954.

MacPhail, Andrew H. "Q and L Score on the ACE Psychological Examination," School and Society, 56:248-251, 1942.

McNemar, Q. "Sampling in Psychological Research," The Psychological Bulletin, 37:384, 1940.

O'Donahue, John. "The Relationship Between Freshman Entrance Examination Scores and Academic Success in the Curriculum of Central Washington College of Education," Unpublished Masters Thesis, Central Washington College of Education, June, 1951.

Remmers, H. H., D. W. Elliott, and N. L. Gage. "Curricular Differences in Predicting Scholastic Achievement: Applications to Counseling," Journal of Educational Psychology, 40:385-394, 1949.

Samenfeld, Herbert W. "Predicting College Achievement," Journal of Higher Education, 24:432-433, November, 1953.

Samuelson, E. E. "The 1954-1955 College Testing Program," Unpublished Study at Central Washington College of Education.

Shuey, Audrey M. "Improvement in Scores on the American Council Psychological Examination from Freshmen to Senior Year," Journal of Educational Research, 39:417-425, 1948.

Silvery, Herbert M. "Changes in Test Scores After Two Years in College," Educational and Psychological Measurements, 11:494-502, Autumn, 1951.

Thomann, Donald F. "Relationship Between the High School and College Editions of the American Council on Educational Psychological Examination and Their Relative Value in Predicting College Achievement," Psychological Abstracts, 22:4631, 1948.

Thomson, William A. "Retest Results on the A.C.E. Psychological Examination," Psychological Bulletin, 36:636, 1939.

Wallace, W. L. "Differential Predictive Value of the ACE Psychological Examination," School and Society, 70:23-25, July 9, 1949.

Willett, G. W. "Reliability of Test Scores on Seven Tests," Journal of Educational Research, 43:293-298, December, 1949.

APPENDIX A: TABLE OF EQUIVALENTS

Q SCORES

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
1	17-18	9	24	39	31
2	19-20	10-11	25	39	31
3	21-23	12-13	26	39	32
4	24	14-15	27	40	32
5	25	16	28	40	33
6	26	17-18	29	40	33
7	27	19	30	41	34
8	28	20	31	41	34
9	29	21	32	41	34
10	30	22	33	42	35
11	31	23	34	42	35
12	32	24	35	42	35
13	32	24	36	43	36
14	33	25	37	43	36
15	34	26	38	43	36
16	35	27	39	43	37
17	36	27	40	44	37
18	36	28	41	44	37
19	37	28	42	44	38
20	37	29	43	44	38
21	37	29	44	45	38
22	38	30	45	45	39
23	38	30	46	45	39

Q Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
46	45	39	69	51	46
47	46	39	70	52	46
48	46	39	71	52	46
49	46	40	72	52	47
50	46	40	73	53	47
51	47	40	74	53	47
52	47	40	75	53	48
53	47	41	76	54	48
54	48	41	77	54	48
55	48	41	78	55	49
56	48	42	79	55	49
57	48	42	80	56	49
58	49	42	81	56	50
59	49	43	82	56	50
60	49	43	83	57	51
61	49	43	84	57	51
62	50	43	85	57	52
63	50	44	86	58	52
64	50	44	87	58	53
65	50	44	88	58	53
66	51	45	89	59	54
67	51	45	90	60	54
68	51	45	91	61	55

Q Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
92	61	55	96	65	59
93	62	56	97	66-67	60-61
94	63	57	98	68-71	62-63
95	64	58	99	72-up	64-up

L Scores

1	27-29	19	19	51	46
2	30-32	20-23	20	52	47
3	33-35	24-26	21	52	48
4	36-37	27-29	22	52	48
5	38	30-31	23	53	49
6	39	32-33	24	53	50
7	40-41	34	25	54	50
8	42	35-36	26	54	51
9	43	37	27	55	51
10	44	38	28	55	52
11	45	39	29	56	52
12	46	40	30	56	53
13	47	41	31	57	53
14	48	42	32	57	54
15	49	43	33	58	54
16	50	44	34	58	55
17	50	45	35	59	56
18	51	46	36	59	56

L Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
37	60	57	61	70	68
38	60	57	62	70	69
39	61	58	63	71	69
40	61	58	64	71	70
41	62	58	65	72	70
42	62	59	66	72	71
43	63	59	67	73	71
44	63	60	68	73	72
45	63	60	69	74	72
46	64	61	70	74	73
47	64	61	71	75	73
48	64	62	72	75	74
49	65	62	73	76	74
50	65	63	74	76	75
51	66	63	75	76	75
52	66	64	76	77	76
53	67	64	77	77	76
54	67	65	78	78	77
55	68	65	79	78	78
56	68	66	80	79	78
57	68	66	81	80	79
58	69	67	82	81	80
59	69	67	83	81	80
60	70	68	84	82	81

L Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
85	82	82	93	90	90
86	83	83	94	91	91
87	83	84	95	91	92-93
88	84	85	96	92-94	94-95
89	85	86	97	95-97n	96-97
90	86	87	98	98-101	98-100
91	87	88	99	102-up	101-up
92	88-89	89			

T Scores

1	34-44	32-down	15	80	73
2	45-51	33-39	16	81	74'
3	52-55	40-44	17	82	75-76
4	56-59	45-48	18	83	77
5	60-62	49-52	19	84	78
6	63-64	53-55	20	85	79-80
7	65-67	56-58	21	86	81
8	68-69	59-61	22	87	82
9	70-71	62-63	23	88	83
10	72-73	64-65	24	89	83
11	74	66-67	25	90	84
12	75-76	68-69	26	91	85
13	77	70	27	91	86
14	78-79	71-72	28	92	87

T Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
29	93	88	53	108	106
30	93	89	54	109	106
31	94	90	55	109	107
32	95	90	56	110	108
33	96	91	57	111	108
34	96	92	58	111	109
35	97	93	59	112	110
36	98	93	60	112	110
37	98	94	61	113	111
38	99	95	62	114	112
39	100	96	63	114	112
40	100	97	64	115	113
41	101	97	65	116	114
42	102	98	66	116	115
43	102	99	67	117	115
44	103	99	68	117	116
45	103	100	69	118	117
46	104	101	70	119	117
47	105	101	71	119	118
48	105	102	72	120	119
49	106	103	73	121	120
50	106	104	74	122	121
51	107	104	75	122	121
52	108	105	76	123	122

T Scores (Con't)

Percentile Rank	Raw Scores 1947	Raw Scores 1952	Percentile Rank	Raw Scores 1947	Raw Scores 1952
77	124	123	89	135	135
78	125	124	90	136	136
79	125	125	91	137	137-138
80	126	126	92	138-139	139-140
81	127	127	93	140	141-142
82	128	128	94	141-143	143-144
83	128	129	95	144-145	145-146
84	129	130	96	146-147	147-149
85	130	131	97	148-150	150-152
86	131	132	98	151-156	153-157
87	132-133	133	99	157-165	158-up
88	134	134			

APPENDIX B: SAMPLE CLASS COMPUTATIONS

1. Coefficient of Correlation between the Q score and the class grades and the regression equation for predicting class grades from the Q score

$$r = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{N}}{\sqrt{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{N}\right)\left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}\right)}} = \frac{216155 - \frac{(5298)(3247)}{83}}{\sqrt{\left(366408 - \frac{(5298)^2}{83}\right)\left(140899 - \frac{(3247)^2}{83}\right)}}$$

$r = .45$

$$\sigma = \frac{1 - r^2}{\sqrt{N-1}} = \frac{1 - (.45)^2}{\sqrt{82}} = .088$$

$$b = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{N}}{\Sigma Y^2 - \frac{(\Sigma Y)^2}{N}} = \frac{216155 - \frac{(5298)(3247)}{83}}{140899 - \frac{(3247)^2}{83}} = .641$$

$$\bar{X} = \frac{5298}{83} = 63.83 \qquad \bar{Y} = \frac{3247}{83} = 38.70$$

$a = \bar{X} - b\bar{Y} = 63.83 - (.641)(39.21) = 25.13$

$X' = 38.70 + .641Y$

X' = the predicted grade
Y = the individual's raw score on the Q section of the ACE
38.70 = a constant to be added
.641 = the regression coefficient

$$\sigma_{x.y} = \sigma_x\sqrt{1 - r^2} = 4.53$$

2. Coefficient of Correlation between the L score and the class grades and the regression equation for predicting class grades from the L score

$$r = \frac{299513 - \frac{(5298)(5487)}{83}}{\sqrt{\left(366408 - \frac{(5298)^2}{83}\right)\left(274399 - \frac{(4587)^2}{83}\right)}} = .28$$

$$r = \frac{1 - (.28)^2}{\sqrt{82}} = .102$$

$$b = \frac{299513 - \frac{(5298)(4587)}{83}}{274399 - \frac{(4587)^2}{83}} = .321$$

$$\bar{X} = \frac{5298}{83} = 63.83 \qquad \bar{Y} = \frac{4587}{83} = 55.26$$

$$a = \bar{X} - b\bar{Y} = 63.83 - (.321)(55.26) = 46.09$$

$$X' = 46.09 + .321Y$$

X' = the predicted grade
Y = the individual's raw score on the L section of the ACE
46.09 = a constant to be added
.321 = the regression coefficient

$$\sigma_{x.y} = \sigma_x \sqrt{1 - r^2} = 5.55$$

3. Coefficient of Correlation between the T score and the class grades and the regression equation for predicting class grades from the T score

$$r = \frac{505990 - \frac{(5298)(7665)}{83}}{\sqrt{\left(366408 - \frac{(5298)^2}{83}\right)\left(755825 - \frac{(7665)^2}{83}\right)}} = .45$$

$$r = \frac{1 - r^2}{\sqrt{82}} = .088$$

$$b = \frac{505990 - \frac{(5298)(7665)}{83}}{755825 - \frac{(7665)^2}{83}} = .349$$

$$\bar{X} = \frac{5298}{83} = 63.83 \qquad \bar{Y} = \frac{7665}{83} = 92.35$$

$$a = \bar{X} - b\bar{Y} = 63.83 - (.349)(92.35) = 31.60$$

$$X' = 31.60 + .349Y$$

X' = the predicted grade
Y = the individual's raw score on the T section of the ACE
31.60 = a constant to be added
.349 = the regression coefficient

$$\sigma_{x.y} = \sigma_x\sqrt{1 - r^2} = 5.55$$

APPENDIX C: REGRESSION EQUATIONS

1. The regression equation for predicting success in B-51 from grades in A-50.

$$X' = 5.19 + .856\ Y$$

X' = the predicted grade in B-51
Y = the individual's numerical grade in A-50
5.19 = a constant to be added
.856 = the regression coefficient

The standard error of estimate is 11.94 (using $\sigma_X \sqrt{1 - r^2}$)

2. The regression equation for predicting success in C-51 from grades in A-50.

$$X' = 21.64 + .683\ Y$$

X' = the predicted grade in C-51
Y = the individuals numerical grade in A-50
21.64 = a constant to be added
.683 = the regression coefficient

The standard error of estimate is 8.16.

3. The regression equation for predicting success in C-52 from grades in A-50.

$$X' = 12.55 + .741\ Y$$

X' = the predicted grade in C-52
Y = the individual's numerical grade in A-50
12.55 = a constant to be added
.741 = the regression coefficient

The standard error of estimate is 7.96.

4. The regression equation for predicting success in C-57 from A-50 grades.

$$X' = 35.44 + .52\ Y$$

X' = the predicted grade in C-57
Y = the individual's numerical grade in A-50
35.44 = a constant to be added
.52 = the regression coefficient

The standard error of estimate is 6.07.

5. The regression equation for predicting success in B-50 from grades in B-2.

$$X' = -9.71 + 1.012\ Y$$

X' = the predicted grade of B-50
Y = the individual's numerical grade in B-2
-9.71 = a constant to be added
1.012 = the regression coefficient

The standard error of estimate is 7.69.

6. The regression equation for predicting success in B-51 from grades in B-2.

$$X' = 17.03 + .664\ Y$$

X' = the predicted grade of B-51
Y = the individual's numerical grade in B-2
17.03 = a constant to be added
.664 = the regression coefficient

The standard error of estimate is 10.17.

7. The regression equation for predicting success in B-51 from grades in B-49.

$$X' = 7.15 + .992\ Y$$

X' = the predicted grade in B-51
Y = the individual's numerical grade in B-51
7.15 = a constant to be added
.992 = the regression coefficient

The standard error os estimate is 12.26.

8. The regression equation for predicting success in C-51 from grades in C-50.

$$X' = 11.92 + .837\ Y$$

X' = the predicted grade in C-51
Y = the individual's numerical grade in C-50
11.92 = a constant to be added
.837 = the regression coefficient

The standard error of estimate is 6.17.

9. The regression equation for predicting success in C-52 from grades in C-50.

$$X' = 14.41 + .74\ Y$$

X' = the predicted grade of C-52
Y = the individual's numerical grade in C-50
14.41 = a constant to be added
.74 = the regression coefficient

The standard error of estimate is 8.08.

10. The regression equation for predicting success in C-57 from grades in C-50.

$$X' = 24.63 + .673\ Y$$

X' = the predicted grade in C-57
Y = the individual's numerical grade in c-50
24.63 = a constant to be added
.673 = the regression coefficient

The standard error of estimate is 8.37.

11. The regression equation for predicting success in C-52 from grades in C-51.

$$X' = 4.51 + .876\ Y$$

X' = the predicted grade in C-52
Y = the individual's numerical grade in C-51
4.51 = a constant to be added
.876 = the regression coefficient

The standard error of estimate is 6.30.

12. The regression equation for predicting success in C-57 from grades in C-51.

$$X' = 23.74 + .719\ Y$$

X' = the predicted grade in C-57
Y = the individual's numerical grade in C-51
23.74 = a constant to be added
.719 = the regression coefficient

The standard error of estimate is 6.81.

13. The regression equation for predicting success in C-57 from grades in C-52.

$$X' = 38.59 + .573\ Y$$

X' = the predicted grade in C-57
Y = the individual's numerical grade in C-52
38.59 = a constant to be added
.573 = the regression coefficient

The standard error of estimate is 4.63.