

1960

An evaluation of the relationship between certain tests and academic achievement on a junior college level.

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1960*

BOSTON UNIVERSITY
SCHOOL OF EDUCATION

Thesis

AN EVALUATION OF THE RELATIONSHIP
BETWEEN CERTAIN TESTS AND ACADEMIC
ACHIEVEMENT ON A JUNIOR
COLLEGE LEVEL

Submitted by

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In Partial Fulfillment of Requirements for
the Degree of Master of Education

1960

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CHAPTER I
INTRODUCTION

1. Statement of Problem

This study has been made for the purpose of determining the degree of relationship between the scores of a battery of tests administered to the freshman class at City Junior College and their academic grades for the freshman year.

2. Justification

Policy of Admission.-- City Junior College has admitted students on the basis of academic grades, test results, and teachers' recommendations from the secondary schools. This data has not been reliable for the prediction of scholastic success or failure. Standardized measuring instruments could be used for the prediction of college marks in a junior college specializing in Home Economics and Art. These findings would assist in the educational guidance of students.

Evaluation of tests in Home Economics.-- Tests in the area of Home Economics were explored and no valid or reliable measurements were found. Ebel said that the Cooperative Test in Foods and Nutrition might be adequate in nutrition but not in foods. There was no data on reliability or validity.^{1/} According to Madden, the Cooperative Test in Home

1/Oscar Kristen Buros (Editor), The Fourth Mental Measurements Year Book, The Gryphon Press, Highland Park, New Jersey, 1953, p. 553.

Management had no evidence of reliability or validity, and the educational aims of the test items were not clear.^{1/} Noll reported that the level of difficulty of this test was such that any college freshman could pass it.^{2/}

Conclusion.-- As a result of these findings, the college selected a battery of standard measurements and asked the writer to administer them to the freshmen during orientation week, September, 1957. Correlations between the scores received by the students and teachers' grades may be of assistance in the prediction of scholastic achievement.

3. Scope

City Junior College.-- This institution, chartered as a junior college for women, gives an associate degree of liberal arts or science to those students who have successfully completed the two year course of study in Home Economics or Art. The total enrollment is 198, of which 95 are seniors and 103 are freshmen.

Courses of Study.-- The following are required courses for all majors in Home Economics:

1. Clothing Construction I
2. Chemistry
3. Child Study
4. Elementary Foods
5. Income and Household Management
6. Line, Design, and Color (a study of color)
7. Psychology (general)

The following courses are required for all Art majors:

1. Clothing Construction I
2. Drawing I
3. Fashion Design

^{1/}Oscar Kristen Buros, op. cit., p. 554.

^{2/}Ibid., p. 555.

4. History of Art
5. Interior Design
6. Mechanical Drawing
7. Mediums (instruction in various techniques used in drawing and painting)

English courses have not been included in this study. The Cooperative English Test scores were used as a basis for the allocation of freshmen to various areas of instruction. These groups were not adapted to the study.

Teachers' Grades.--- The grades used were those received by the study sample at the end of the freshman year in college. These marks include all written work, quizzes, term papers, examinations, oral responses, and behavior which the instructors used in the evaluation of the marks of the individual students.

The Test Battery.--- The tests included in the Battery were:

1. The Cooperative English Test, C2: Reading Comprehension, (Higher Level), Form R^{1/}
2. The Otis Self-Administering Test of Mental Ability, Higher Examination: Form A^{2/}
3. The American Council on Education, Psychological Examination for College Freshmen, 1954 Edition^{3/}

Additional references to these tests will be abridged to ACE, Otis

1/Educational Testing Service, Cooperative Test Division, Cooperative English Test, C2: Reading Comprehension (Higher Level), Princeton, New Jersey.

2/Arthur S. Otis, Otis Self-Administering Tests of Mental Ability, Higher Examination: Form A, World Book Company, Yonkers-on-Hudson, New York, 1950.

3/Educational Testing Service, Cooperative Test Division, American Council on Education, Psychological Examination for College Freshmen, 1954 Edition, Princeton, New Jersey, 1954.

SA, and Coop C2.

Study Sample.-- This study has been concerned with the 103 freshmen who entered City Junior College in September, 1957. The variations which have limited the sample are shown in Table 1.

Table 1. Variations in the original study sample.

Variations	H.E.	Art	Total
(1)	(2)	(3)	(4)
Language handicap--	2	1	3
Withdrawals-----	3	1	4
Academic failures-- (first semester)	1	2	3
Total variations--	6	4	10
Study Sample-----	64	29	93
Original Sample--	70	33	103

4. Limitations

Any study which has attempted to find correlations between standardized measurements and teachers' marks has limitations. Doppelt and Weseman have advised that instructors' marks were replete with evaluations of the student's motivations, study habits, verbal fluency, and other estimates. Such values, which exemplify the individual teacher's appraisal of these attributes, were nor measurable.^{1/}

^{1/}Doppelt, Jerome E. and Alexander G. Weseman, "Differential Aptitude Tests as Predictors of Achievement Test Scores," Journal of Educational Psychology, (1952), 43: 210-217.

There were no valid and reliable tools for the measurement of "drive" and "motivation." Monroe stressed the importance of individual differences in the consideration of "normal adjustment."^{1/} Lehner emphasized the great need for the study of the relatively low correlation between ability and achievement and the emotional factors which influence these correlations.^{2/}

It is evident that teachers' marks were always suspect; however, they were the standards used in determining student grades.

5. Restatement of Problem

This study has been for the purpose of determining the relationship between the test scores of the ACE, Otis SA, and Coop Cl, and the academic grades made by the study sample composed of 93 freshmen at City Junior College.

^{1/}Walter S. Monroe, (Editor), Encyclopedia of Educational Research, The Macmillan Company, New York, 1950, p. 509.

^{2/}George F.J. Lehner and Ella Kube, The Dynamics of Personal Adjustment, Prentice-Hall Co., Inc., New Jersey, 1957, pp. 437-438.

CHAPTER II

REVIEW OF RELATED RESEARCH

1. Scope

The basic postulate of testing is the measurement of individual differences. From the analysis and refinement of these differences between individuals, the use of tests as prognostic tools has been developed. As Cronbach has stated, "an attempt to predict underlies every use of testing."^{1/} A brief review of the development of testing will relate these prognostic measurements to the study.

One of the most common criteria employed in the validation of tests is some measurement of scholastic achievement.^{2/} In order to use the ACE, Otis SA, and Coop C2 in the prediction of the level of academic grades, an appraisal of related research was essential to establish the validity of the tests in this area.

2. Historical Background

Early History.--- Francis Galton, the English biologist of the nineteenth century, through his interest in heredity, explored diverse methods of measuring individual differences.^{3/} From the studies of Galton and Karl Pearson arose not only the measurement of the amount of

^{1/}Lee J. Cronbach, Essentials of Psychological Testing, Harper and Brothers, New York, 1949, p. 9.

^{2/}Anna Anastasi, Psychological Testing, The Macmillan Co., 1956, p. 138.

^{3/}Ibid., pp. 7-8.

variation of a frequency distribution, but "the study of the qualitative problems of the type, or form, of the variation. Especially important is the study of the simultaneous variations of two or more variates."^{1/}

Galton adapted and refined certain of the mathematical techniques so that the mathematically untrained could treat test data quantitatively.^{2/}

James Cattell, an American psychologist, whose doctorate dissertation was based upon individual differences, secured further support for his ideas from Galton. Cattell represented the union of the field of experimental psychology with the new field of testing. He developed Galton's theory of the measurement of intellectual functions by tests of "sensory discrimination and reaction time." Cattell tested school children, college students and adults, but the evaluation of the results showed little correlation between tests.^{3/}

Parallel with the development of measurements of sensory factors, a group of European psychologists were devising tests to determine the basic factors which characterized abnormal individuals. These tests were composed of simple arithmetic problems and designed to measure memory, and anxiety reactions. In 1885, Ebbinghaus, a German psychologist, administered sentence completion tests to school children which showed a definite correlation with the children's academic achievement.^{4/}

^{1/}Sir Ronald A. Fisher, Statistical Methods for Research Workers, (Twelfth Edition-Revised), Hafner Publishing Company, Inc., New York, 1954, pp. 4-5.

^{2/}Anna Anastasi, op. cit., p. 8.

^{3/}Ibid., pp. 8-9.

^{4/}Ibid., p. 9.

Alfred Binet, the French psychologist, had been exploring many different tests in order to differentiate between the behavior of bright and dull children when the schools of Paris asked him to construct a test which could distinguish those children which were educable from those who were not. In collaboration with Simon, Binet produced the first practical mental test in 1904. In 1910, Lewis M. Terman began his research with the Binet tests and published his results in the form of the Stanford Revision of the Binet Scale in 1916. This measurement was received enthusiastically by American psychologists because of its objectivity and lack of bias.^{1/}

Recent History.-- The Binet Scales, which are individual tests, were used as criteria for the validation of new measurements. Group testing was developed during World War I to assist the United States Army in the selection of adequate personnel. The Army Alpha and Army Beta were constructed from group intelligence tests of Arthur S. Otis. These group measures were widely accepted because of their practical value in predicting what they were devised to predict. After their release to the general public for use, these tests and their many revisions "served as models for most group intelligence tests." One of the latest revisions of these measurements, the Otis SA, was used in this study.^{2/}

1/Lee J. Cronbach, op. cit., pp. 102-103.

2/Anna Anastasi, op. cit., pp. 11-12.

2. The ACE, Otis SA, and Coop C2 as predictors of academic achievement

The ACE.-- This test was devised by L. L. Thurstone and Thelma Gwinn Thurstone in 1925. Since 1947 the staff of the Educational Testing Service has constructed the test from materials developed by the authors. The purpose of the standardized measurement is "for the appraisal of scholastic aptitude, or general intelligence, with reference to the requirements of most college curricula."^{1/}

The test is composed of six sub-tests, each of which is preceded by separately timed practice exercises. The three sub-tests in the linguistic portion of the ACE are: (1) same-opposite, (2) completion, (3) verbal analogies. The three quantitative sub-tests are: (1) arithmetical reasoning, (2) number series, (3) figure analogies. The working time of the test is one hour.^{2/}

The ACE Norms Bulletin gives the measures of central tendency and percentile ranks of the Q, L, and total scores for the 186 colleges reporting on the ACE in 1954. It is easy to find the percentile rank of any individual score with reference to the total population of 26,603 scores reported for that year.^{3/}

Thurstone obtained an average coefficient of correlation of .45

^{1/}Educational Testing Service, Cooperative Test Division, Catalog, Princeton, New Jersey, 1956.

^{2/}Educational Testing Service, Cooperative Test Division, American Council on Education, Psychological Examination for College Freshmen, 1954 Edition, Princeton, New Jersey.

^{3/}Educational Testing Service, Cooperative Test Division, ACE, Psychological Examination for College Freshmen, 1954 Edition, Norms Bulletin, (Revised), Princeton, New Jersey.

between the total test scores and freshman academic grades for the 26 colleges reporting.^{1/} Kelly reported a Spearman-Brown coefficient of reliability of .71 for the Q sub-tests, .78 for the L sub-tests, and .959 for the total test.^{2/}

In the reviews of the ACE in Buros, Thorndike^{3/} and Guilford^{4/} referred to the excellent workmanship and research which were used in the construction of the test. Guilford found the verbal factor so controlled that it did not allow linguistic ability to influence the scores in other areas.

Wrenn, in a review of a survey by Lange, stated that 75 per cent of the reporting colleges used the ACE for the prediction of academic achievement.^{5/} Correlations ranging from .30 to .50 between the ACE and instructors' grades were noted by Anastasi.^{6/}

A correlation of .489 between the ACE and the first semester grade point averages at the University of Wisconsin was obtained by Lins.^{7/}

1/L. L. Thurstone, "Psychological Tests for College Freshmen," Educational Record, (1925), 6: 69-83.

2/Truman L. Kelly, Interpretation of Educational Measurements, World Book Company, Yonkers-on-Hudson, New York, 1925, p. 302.

3/Oscar Kristen Buros (Editor), The Third Mental Measurements Year Book, Rutgers University Press, New Brunswick, New Jersey, 1948, p. 201.

4/Ibid., pp. 297-298.

5/C. G. Wrenn, Student Personnel Work in College, Harper and Brothers, Inc., New York, 1951, pp. 279-281.

6/Anna Anastasi, op. cit., p. 224.

7/L. J. Lins, "Probability Approach to Forecasting University Success with Measured Grades as the Criteria," Educational and Psychological Measurement, (1950), 10: pp. 386-391.

Boyer and Koken considered an r of .53 between ACE centile ranks and quality grade point averages to be an indication of close correspondence between "predicted" and "achieved" quality point averages for the mass of "average" students.^{1/} In a study of the relationship between the ACE and grade point averages of 427 students at the California College of Arts and Crafts, Borg reported correlations of .16 for the Q score, .26 for the L score, and .26 for the total score. These low quotients were significant at the 1 per cent level of confidence. Borg drew the conclusion that ACE measures certain aspects of the intelligence of Art students.^{2/}

Of the many investigations relative to correlation of the ACE with individual course grades, Wallace recorded coefficients of .30 in History and .45 in Chemistry.^{3/} Portenier derived a correlation of .47 in General Psychology.^{4/} Coefficients of .30 in Chemistry and .41 in History were obtained by McIntire.^{5/} Lannigan secured correlations of

^{1/}Lee E. Boyer and James E. Koken, "Admission Tests as Criteria for Success in College," Journal of Educational Research, (1956), 50: 13-15.

^{2/}Walter R. Borg, "A Study of the Relationship between General Intelligence and Success in an Art College," The Journal of Educational Psychology, (1949), 40: 434-436.

^{3/}W. L. Wallace, "The Prediction of Grades in Specific College Courses," The Journal of Educational Psychology, (1951), 44: 487-597.

^{4/}Lillian G. Portenier, "Predicting Success in Introductory Psychology, Educational and Psychological Measurements, (1948), 8: 117-126.

^{5/}Paul R. McIntire, The Construction and Evaluation of a Work Sample Test for College Freshmen, Unpublished Doctoral Dissertation, Boston University School of Education, 1957.

.50 in Social Studies and .442 in the Sciences.^{1/} Norton, in a study of the validation of the National League of Nursing Education Test Battery at the School for Nurses, Peter Bent Brigham Hospital, derived correlations between the ACE test scores and instructors' grades of .60 in Biological Science and .61 in Social Sciences.^{2/}

In a study of the relationship of the scores on the ACE course grades at Brown University, MacPhail reported the following correlations:^{3/}

Table 2. Correlations between the ACE and first semester grades.

Courses	A C E		
	N	Q	L
(1)	(2)	(3)	(4)
Science (B) in Chemistry-----	28	.34	.31
AB in Chemistry-----	321	.55	.56
General Psychology-----	401	.25	.41
All degrees-----	401	.39	.52

Angoff found coefficients ranging from .35 to .63 between the scores of the SAT-V and SAT-M and the ACE for 1141 students.^{4/} Super gave

1/Mary A. Lannigan, The Effectiveness of the Otis, the ACE and the Minnesota Speed of Reading Test for Predicting Success in College, Unpublished Master's Thesis, Boston University School of Education, 1947.

2/Irene Norton, Validation of the National League of Nursing Education Pre-Nursing and Guidance Battery for Applicants to the Peter Bent Brigham Hospital School of Nursing, Unpublished Master's Thesis, Boston University School of Education, 1953.

3/Andrew H. MacPhail, "Q and L scores on the ACE Psychological Examination," School and Society, (1942), 56: 248-251.

4/William H. Angoff, "The 'Equalling' of Non-Parallel Tests," Journal of Experimental Education, (1957), 25: 241-247.

additional weight to the validity of the ACE as a prognostic measure by reporting correlations ranging from .49 to .69 between this test and the 1937 Revision of the Stanford-Binet Scales and the Wechsler Bellevue Scales (W-B I).^{1/}

Summary.--- The relationship between the test scores of the ACE and academic achievement is the most direct source of data concerning its validity for the prediction of scholastic achievement. The results of these investigations gave positive correlations from .16 to .55 for the Q score, .26 to .61 for the L score, and the total scores clustered around .45.

The Otis SA.--- This test, which was designed for high school seniors and college freshmen, was constructed by Arthur S. Otis and has continued under his supervision for the past 36 years. It contains 75 test items which are arranged according to difficulty. The working time is either 20 or 30 minutes. Tests administered in 20 minutes may be translated into terms of 30-minute time limit scores so that they may be compared with the norms.^{2/} Mursell refers to the "self-administering" feature of the test which is based upon the "scrambled" or "spiral omnibus" arrangements of the test items,^{3/} which include arithmetic, spatial perception, vocabulary, sentence meaning, proverbs, number series,

1/Donald E. Super, Appraising Vocational Fitness, Harper and Brothers, Inc., New York, 1949, p. 117.

2/Arthur S. Otis, Otis Self-Administering Tests of Mental Ability, Manual of Directions and Key, World Book Company, Yonkers-on-Hudson, New York, 1928.

3/James L. Mursell, Psychological Testing, (Second Edition), Longmans, Green and Company, New York, 1950, pp. 155-159.

and analogies.^{1/}

Otis reported reliability coefficients from .92 to .94 and a validity of .84 to .88. The median for college students is a raw score of .53.^{2/} Kuder, in a review in Buros, described the Otis SA as a predictive measure of college success which compared favorably with other measurements of general ability.^{3/} Super placed a high value on the Otis SA as a tool for research in predictive studies of academic achievement.^{4/}

This study, made by Segal in 1931, has been included because it concerns the prediction of academic success in a junior college. The author found that the correlations of the Otis SA with the high school grades of a group of junior college freshmen was .31, in contrast to a coefficient of .54 when this measurement was correlated with the college grades of the group.^{5/} Lannigan, in an investigation of the relationship between Otis SA and grade point averages of freshmen in a four-year college, obtained correlations of .42 in Social Studies and .53 with Science.^{6/}

^{1/}Arthur S. Otis, Otis Self-Administering Tests of Mental Ability, Higher Examination: Form A, World Book Company, Yonkers-on-Hudson, New York, 1950.

^{2/}Arthur S. Otis, Manual, op. cit.

^{3/}Oscar Kristen Buros (Editor), Third Mental Measurements Year Book, Rutgers University Press, New Brunswick, New Jersey, 1949, p. 251.

^{4/}Donald E. Super, op. cit., pp. 108-114.

^{5/}David Segal, "Predictions of Success in Junior College," Junior College Journal, 1931, pp. 449-502.

^{6/}Mary Lannigan, op. cit., p. 49.

Goodman used the Otis SA in the validation of the findings of a study of the prediction of college success by Thurstone's PMA. The correlations of the Otis SA with grades for Home Economics students were .37 in Chemistry and .46 in Personal Problems, a course which approximates Hygiene as taught in City Junior College.^{1/}

The Otis SA shows a significant correspondence with both individual and group tests. Super reports coefficients of .70 with the Army Alpha, .55 with the Terman Group Test of Mental Ability, .50 with the Revised Stanford Binet Scale, and .73 with the Wechsler Bellevue (W-B-I).^{2/}

Summary.--- The validity of the Otis SA is supported by the review of the correlations of its test scores with academic achievement. The results of the investigation gave positive correlations from .31 to .54 with scholastic performance and .50 and .73 with individual tests.

Coop C2.--- This test, which has a working time of 40 minutes, is designed to measure the thinking processes in reading on the grounds that effective reading is not a mechanical process but an active reading and associational process.^{3/} The measurement is composed of two parts, vocabulary and comprehension. The raw scores are scaled and translated into four separate centile ranks: vocabulary, speed of comprehension, level of comprehension, and total reading score.^{4/} The Cooperative Test Division

^{1/}Charles H. Goodman, "Predictions of College Success by means of Thurstone's Primary Ability Tests," Educational and Psychological Measurements, (1944) 4: 125-140.

^{2/}Donald E. Super, op. cit., pp. 108-114.

^{3/}Educational Testing Service, Cooperative Test Division, Catalog, Princeton, New Jersey, 1956.

^{4/}Ibid.

of the Educational Testing Service, which publishes the measurement, reported a reliability coefficient of .92.^{1/}

Bear, in a review of the Coop C2 in Buros, stressed the careful standardization of the test and the elimination of the speed factor from the level of comprehension and total test scores. He reported correlations of .7 and .8 with intelligence tests and coefficients from .39 to .75 with school grades.^{2/} Strand has stated that it would be difficult to find a better test, within the limits of its objectives.^{3/}

Traxler, in a study of 541 private school students, secured correlations from .54 to .78 with course grades.^{4/} Correlations of .53, .58, and .44 between the Coop C2 and teachers' grades in General Science in a school of nursing, where the grades were reliable, were reported by Williamson.^{5/}

The significant correspondence of the Coop C2 with academic achievement is exemplified by the use of the Coop C2 as a variable in a validation study. In this project, the correlations with freshman grade point

1/Educational Testing Service, Cooperative Test Division, The Cooperative Reading Comprehension Tests, Information Concerning Their Construction, Interpretation, and Use, Princeton, New Jersey.

2/Oscar Kristen Buros, op. cit., p. 497.

3/Ibid., p. 498.

4/Arthur E. Traxler, "1940 Achievement Testing Program in Independent Schools and Supplementary Studies," Educational Records Bulletin, (1940), 30.

5/E.G. Williamson et al, "The Selection of Student Nurses," Journal of Applied Psychology, (1938), 22: 119-131.

averages were .198 and .140.^{1/} Utilizing the test in like manner, McIntire derived statistically significant correlations between the Coop C2 and grade point average of 852 students.^{2/}

Liberal Arts	-----	r .39
Technical	-----	r .40
Chemistry	-----	r .43
Psychology	-----	r .40

Summary.--- The results of the review gave positive correlations from .14 to .78 with grade averages and coefficients which clustered around .45 in Science and Chemistry. The relationship between the Coop C2 and course grades was the most direct source of data concerning the validity of the test in the prediction of academic performance.

4. Teachers' Grades as Criteria for Validity

Teachers' marks are the most common criteria for the validation of tests for the prediction of academic achievement. The majority of studies of the prognostic measurements have used course grades as an index of validity.

1/George W. Angell, Jr., Construction and Evaluation of a Measure of Study Abilities, Unpublished doctoral dissertation, Boston University School of Education, 1954.

2/Frank R. McIntire, op. cit.

CHAPTER III
METHODS OF RESEARCH

Administration of Tests.-- The writer administered the Coop C2, the Otis SA, and the ACE to the total sample group in September, 1957. The tests were corrected by IBM machines.

Measures of Central Tendency.-- The mean, standard deviation, and median were calculated for the test scores and for the grades in each individual course. Because all computations were made by hand, the following formulae for group data were used:^{1/}

$$\text{Mean (M)} = M' + i \left(\frac{fx'_{i}}{N} \right)$$

$$\text{Median (Mdn)} = L - \left(\frac{N/2 - F_b}{f_p} \right) i$$

$$\text{Standard Deviation (σ)} = i \sqrt{\frac{fx'^2}{N} - \left(\frac{fx'_{i}}{N} \right)^2}$$

Two-Way Frequency Distribution.^{2/} Because of their many advantages, two-way frequency distributions were utilized in compiling the data used in the computation of the statistical validity of the ACE, Otis SA, and Coop C2 as predictors of academic achievement. Such correlation tables allow for the examination of students' grades in specific subjects with reference to their various test scores. The paired scores make it

^{1/} J.P. Guilford, op. cit., p. 67.

^{2/} James E. Wert, Clarence O. Neidt, and J. Stanley Arman, Statistical Methods in Educational and Psychological Research, Appleton-Century-Crofts, Inc., 1954, p. 61.

possible to compare student grades in one course with the matching scores received in another course. A superficial examination of the table will show the flow and scatter of the scores.^{1/}

Correlations.-- Inter-test coefficients of correlation and coefficients between each test and course grades were computed. A variation of the Pearson Product-Moment formula for raw scores as applied to a two-way frequency was used:^{2/}

$$r_{xy} = \frac{dx dy - \frac{(f_y d_y)(f_x d_x)}{N}}{\sqrt{\left[f_x d_x^2 - \left(\frac{f_x d_x}{N} \right)^2 \right] \left[f_y d_y^2 - \left(\frac{f_y d_y}{N} \right)^2 \right]}}$$

T-ratio.-- Fisher's t-ratio formula for small samples,^{3/} as suggested by Guilford,^{4/} was applied to all coefficients of correlation.

$$t = r \sqrt{\frac{N - 2}{1 - r^2}}$$

Null Hypothesis.-- The one per cent and five percent levels of confidence were calculated on the basis of $N - 2$ degrees of freedom. Two degrees have previously been used in the computation of the means of the paired tests.

Summary.-- In order to determine statistically the prognostic value of the ACE, the Otis SA, and the Coop C2 in relation to the grades of the

^{1/}Henry E. Garrett, Statistics in Psychology and Education, Longmans, Green, and Company, New York, 1953, pp. 129-130.

^{2/}James E. Wert, op. cit., p. 83.

^{3/}Ronald A. Fisher, op. cit., p. 193.

^{4/}J. P. Guilford, op. cit. p. 208.

study sample, the following procedures were considered advisable:

1. The use of the measures of central tendency and variability for the statistical description of the test scores and academic grades of the study sample.
2. The use of intercorrelation coefficients of validity in the statistical interpretation of the relation between test scores and academic grades of the sample.
3. The use of t-ratios for the statistical description of the coefficients of correlation in relation to the Null hypothesis.

CHAPTER IV

PRESENTATION OF FINDINGS

1. Study Sample

Composition.-- The variations which occurred in the original study sample limit the group to 93, with 64 in the Home Economics and 29 in the Art samples. The means and standard deviations of the ages of these freshmen show a factor of homogeneity, as indicated in Table 3.

Table 3. Mean and Standard Deviation of Ages of Freshmen in the Study Sample.

Measures of Central Tendency	H.E.	Art	Total
(1)	(2)	(3)	(4)
Mean -----	18.4	17.9	18.1
S.D. -----	.83	.85	.86

Measurements of Central Tendency.-- The means, medians, and standard deviations of the ACE, Otis SA, and Coop C2 are given in Table 4.

Table 4. Measurements of Central Tendency of Scores of ACE, Otis SA and Coop C2.

Tests	Home Economics			Art			Total Sample		
	M.	Mdn.	S.D.	M.	Mdn.	S.D.	M.	Mdn.	S.D.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ACE									
TS	79.00	78.62	17.29	84.89	85.13	15.62	81.59	80.44	16.81
QS	28.81	28.45	11.14	30.98	31.38	7.98	29.59	28.99	10.82
LS	52.54	47.55	9.42	54.77	55.68	7.81	53.24	52.69	8.94
O-SA	50.81	50.27	7.78	50.92	50.42	7.64	50.82	50.17	7.76
C-C2	81.23	80.22	21.52	82.94	75.13	15.49	81.61	78.62	22.18

The ACE Norms Bulletin has presented the centile ranks of the mean Q, L, and Total Score based upon the distribution of 26,603 scores reported. "The percentile ranks indicate the proportion of scores that were equal to or lower than the score submitted by a particular type of college."^{1/} The centile ranks of the means of the ACE scores of the study sample, as reported for junior colleges for women, are given in Table 5.^{2/}

Table 5. Centile ranks of the Mean Study Sample Scores.

ACE	Home Economics	Art	Total
	%ile Rank	%ile Rank	%ile Rank
(1)	(2)	(3)	(4)
Total Score	40	51	45
Q	46	54	50
L	45	51	45

^{1/}Educational Testing Service, Cooperative Test Division, American Council on Education for College Freshmen (1954 Edition), Norms Bulletin (Revised), Princeton, New Jersey, 1955, p. 2.

^{2/}Ibid., pp. 6-18.

An inspection of this data indicates that the Home Economics sample is below the average of the ACE normative population for freshmen in junior colleges for women and the Art sample is at the average of the normative group.

Otis SA.--- The means and medians of the Otis SA scores are approximately 50. Otis equivalent for this raw score is an I.Q. of 108 for an individual 18 years of age.^{1/} This quotient corresponds to a median I.Q. of 109 reported for college students by Traxler.^{2/}

Coop C2.--- Comparable data are not available for this test. The norms for the Coop C2 are based upon the theory that many groups of scores with varied means and standard deviations can be normally distributed on the same basic scale.^{3/} "It is clear that in selecting cases for such a standardization, there must be a number of relatively arbitrary decisions and assumptions. A system for normalizing many distributions on the same abscissa, in a manner that is replete with significant data and confidence levels, is yet to be devised."^{4/}

Variability.--- A comparison of the relationship between the means and medians of a distribution gives information concerning skewness.^{5/}

1/Arthur S. Otis, Self-Administering Tests of Mental Ability, Manual of Directions and Key, (Revised), World Book Co., Yonkers-on-Hudson, New York, 1928.

2/Arthur Traxler, "What is a Satisfactory I.Q. for Admission to College?" School and Society, (1941), 51: 462-464.

3/Harold Gulliksen, The Theory of Mental Tests, John Wiley and Sons, Inc., New York, 1950, p. 284.

4/Ibid., p. 285.

5/J.P. Guilford, op. cit., p. 76.

The medians of the ACE sample are higher than the means, signifying negative skewing. The remaining test scores exhibit various degrees of positive skewing, with that of the Otis SA so slight that it approximates a normal distribution. This data may imply that the level of difficulty of the ACE was high for the Home Economics sample and that of the Coop C2 high for both groups.

The ACE Norms Bulletin reported the standard deviations for the scores of the junior colleges for women to be 10.50 for the Q score, 14.46 for the L score, and 22.33 for the total score.^{1/} The lower standard deviations of the study sample indicate that the group is more homogeneous than the normative population.

Summary.--- The study sample of 93 freshmen, 64 in Home Economics and 29 in Art, has a mean age of 18.1 years. The group is more homogeneous than the ACE normative population. The Home Economics sample is below the average of the junior college percentile ranks, the Art sample is at the average. Positive skewness is present in the Coop C2 scores for both groups, and in the ACE for the Home Economics sample. The ACE scores of the Art sample are negatively skewed, whereas the scores of the Otis SA approximates a normal distribution. The intelligence quotients of the sample are average for college students.

2. Course Grades

Grading Scale.--- The course grades at City College are based upon the following numerical values:

1/Norms Bulletin, op. cit., pp. 10, 12, 17.

90 - 100	-----	A
80 - 89	-----	B
70 - 79	-----	C
60 - 69	-----	D
0 - 59	-----	F

Measures of Central Tendency.--- An inspection of statistics presented in Tables 5 and 6 indicates that 12 of the 16 means of the course grades fall in the 80-90 grade value of "B."

Table 6. Measures of Central Tendency of Course Grades

Courses	Home Economics			Courses	Art		
	Mean	Mdn.	S.D.		Mean	Mdn.	S.D.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chemistry -	80.23	82.50	17.29	Clothing -	79.60	80.96	8.43
Child Dev. -	81.30	82.01	6.84	Design -	82.58	85.91	5.34
Clothing -	80.50	82.00	19.17	Des.Theory -	84.14	85.01	5.32
Foods -	80.39	82.90	6.83	Drawing -	84.49	85.14	5.71
Household Management -	83.97	84.73	7.68	Fashion Design -	82.58	82.95	5.34
Hygiene -	80.61	82.94	9.76	History of Art -	75.42	75.62	9.31
Line, Design and Color -	83.17	85.08	5.69	Interior Design -	75.33	75.90	6.75
Psychology -	74.95	80.70	22.14	Mechan. Drawing -	80.80	79.99	5.70
				Mediums -	82.75	84.49	5.12

Guilford has stated that, "We can predict that a student's marks in a course will be somewhere in the range from A to F inclusive, and most probably it will be a mark of C, which more students earn than any other mark."^{1/} The medians of the Home Economics sample specify that

1/J.P. Guilford, op. cit., p. 364.

50 per cent of the freshmen received grades of 82 or better. In contrast, 50 per cent of the Art sample received marks ranging from 75 to 83. Evaluations of this type express a marked variation in the values commonly assigned to course grades.^{1/}

Common grading practices make it difficult to accept mean grades ranging from 80 to 84. Fisher reminds us that each individual would receive the mean score, were deviations equally divided.^{2/}

Variability.-- A comparison of the means and medians of the course grades reveals varying degrees of negative skewing. Table 7 records the cumulative number and percentage of students in each interval of the grading scale.

Table 7. Cumulative number and percentage of students in each interval of grading scale.

Samples	Course Grades											Total	
	N	0-59	%	60-69	%	70-79	%	80-89	%	90-99	%	0-99	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
H.Econ	64	16	3	46	9	149	29	236	46	65	13	512	100
Art	29	2	1	16	7	77	33	118	51	19	8	232	100
Total	93	18	2	62	8	226	31	354	48	84	11	744	100

Course grades do not evidence any relationship to a normal distribution when 48 per cent and 51 per cent of the scores have a value of 80-90.

^{1/}J.P. Guilford, op. cit., p. 76.

^{2/}Sir Ronald A. Fisher, op. cit., p. 48.

Summary.-- A numerical value that is higher than the accepted standard is used in the course grades, causing a marked degree of skewness.

3. Inter-test Correlations of Test Scores.

Statistical Significance.-- Significant correlations between tests indicate that individuals whose test scores are above the average in one variable are above the average in the second, that those whose scores are below the average in one are correspondingly below in the other, and those scores which cluster around the average in one, will gravitate toward the average in the other.^{1/}

The inter-test correlations, together with the t-ratios, which are statistically significant at the one per cent level of confidence, are noted in Tables 8, 9, and 10. Although the correlations range from .32 to .75, the t-ratios are large. Guilford has specified that there is less than one chance in 100 that a t as large or larger than 2.58 could have occurred by chance.^{2/} Although these smaller coefficients are statistically significant, they represent varying degrees of relationship between the tests. Such variance may be interpreted by the coefficient of alienation, percentage of reduction in errors for the prediction of one test from another, and the percentage of variance accounted for.

(See Appendix 40).^{3/} The percentage of reduction of errors of prediction varies from six per cent for a correlation of .32, with 10 per cent of the variance accounted for, to a 35 per cent reduction in error for a

^{1/}E.F. Linquist, A First Course in Statistics, Houghton Mifflin Company, Boston, 1938, p. 137.

^{2/}J.P. Guilford, op. cit., p. 209.

^{3/}Ibid., pp. 408-411.

Table 8. Summary of Correlations and t-ratios of the ACE, Otis SA, and Coop C2 for 64 freshmen majoring in Home Economics. 1/

Test	ACE						Otis	
	Q Score	t-Score	L Score	t-Score	Total Score	t-Score	SA Score	t-Score
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Coop C2	.32	3.22	.76	9.40	.63	6.24	.63	6.24
Otis SA	.43	3.67	.60	5.90	.65	6.73		

Table 9. Summary of Correlations and t-ratios of the ACE, Otis SA, and Coop C2 for 29 freshmen majoring in Art. 1/

Test	ACE						Otis	
	Q Score	t-Score	L Score	t-Score	Total Score	t-Score	SA Score	t-Score
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Coop C2	.58	3.70	.64	4.32	.62	4.09	.60	3.89
Otis SA	.65	4.44	.58	3.70	.61	3.99		

Table 10. Summary of Correlations and t-ratios of the ACE, Otis SA, and Coop C2 for the 93 freshmen of the total sample. 1/

Test	ACE						Otis	
	Q Score	t-Score	L Score	t-Score	Total Score	t-Score	SA Score	t-Score
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Coop C2	.40	4.19	.75	10.81	.65	8.15	.61	7.39
Otis SA	.52	5.80	.55	6.14	.63	7.69		

1/All t-scores are statistically significant at five and one per cent levels of confidence.

correlation of .76, with 58 per cent of the variance accounted for. A reduction of six per cent in the errors of prediction may seem small, but when proceeding from 0 reductions of errors, the 6 per cent assumes a much greater significance.

Validity.-- The degrees of correspondence between the various test scores indicate that there were definite areas in which student performance on the various tests were parallel. This close relationship establishes the validity of the ACE, Otis SA, and Coop C2 as predictors of academic achievement for the study sample.

4. Correlation of the ACE, Otis SA, and Coop C2 with Course Grades.

Home Economics Sample.-- The coefficients of correlation between the ACE, Otis SA, and Coop C2 are statistically significant for Chemistry and the ACE Q score, and Hygiene and the Coop C2. The correlations and t-ratios are shown in Table 11.

An inspection of a two-way frequency distribution of the Home Economics course grades and the ACE (see Appendix, 38) denotes the diversity of the placement of individual students by different instructors. There is little correspondence between course grade values and the above average, below average, or mean position of students in the distribution of the test scores.

The Art Sample.-- Although this group evidenced a definite degree of negative skewing, certain courses showed a definite relationship to the test scores. An inspection of the two-way distribution of the Art sample marks and the Otis SA indicates that, although the course grades

Table 11. Correlations of Test Scores and t-ratios of ACE, Otis SA and Coop G2 with grades of 64 freshmen in the Home Economics Sample.

Criteria	ACE						Otis SA		Coop G2	
	Q		L		Total		r	t	r	t
	r	t	r	t	r	t				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Chemistry	.39	3.33**	.03	***	.21	1.68	.14	1.11	.15	1.20
Child Dev.	.03	***	.11	.87	.25	2.16	.21	1.66	.21	1.66
Clothing	.11	.87	-.03	***	.09	***	.04	***	-.09	***
Foods	.09	***	.06	***	.20	1.66	.15	1.20	-.01	***
Household Management	.11	.87	-.10	***	.18	1.32	.15	1.20	-.03	***
Hygiene	.01	***	.24	2.01	.21	1.66	.21	1.66	.39	3.33**
Line, Design and Color	.14	1.11	.02	***	.09	***	.19	1.37	.22	1.71
Psychology	.05	***	.02	***	.03	***	.05	***	.11	.87

* - 0.05 per cent level of confidence

** - 0.01 per cent level of confidence

*** - spurious

placed a higher value on student performance, the relative placement in the distribution had many parallel factors. (See Appendix 39).

The correlation of test scores with the t-ratio, as noted in Table 12, indicates that the t-ratios of three courses were significant at the one per cent level of confidence and six were significant at the five per cent level, in relation to the ACE total scores. All courses were also significantly correspondent to the Otis SA, five showing significance at the five per cent level and three at the one per cent level. History of Art and Interior Design, courses with little skewing whose means were at .75, showed a significant relationship with all test scores. In comparison, Fashion Design, with skewness and a mean of 84, assigned course grades which were significant with all tests.

The degree of statistical significance of the course grades of the Art sample is in proportion to correspondence with the placement of students in the above average, below average, and average areas of the distribution.

The writer is unable to place great confidence in the statistically significant data evidenced by this sample. * Distributions which place 51 per cent of the cases in the 80-90 interval are not symptomatic of common practice in grading systems

5. Summary

The study sample of 93, 64 of which are Home Economics and 29 Art, secured test scores which were significantly correspondent to give the tests validity for the sample.

The distributions of the test scores were negatively skewed and departed from any relationship to a normal curve.

Table 12. Correlations of Test Scores and t-ratios of ACE, Otis SA and Coop C2 with grades of 29 freshmen in the Art Sample.

Criteria	ACE						Otis SA		Coop C2	
	Q		L		Total		r	t	r	t
	r	t	r	t	r	t				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
History of Art	.43	* 2.49	.49	* 2.84	.51	* 3.06	.56	** 3.52	.58	** 3.71
Interior Design	.46	* 2.66	.47	* 2.72	.46	* 2.66	.70	** 5.04	.58	** 3.71
Mechanical Drawing	.35	1.92	.38	2.12	.51	* 3.06	.40	2.28	.38	2.12
Mediums	.30	1.62	.38	2.12	.51	* 3.06	.51	* 3.06	.44	* 2.55
Drawing	.32	1.73	.42	2.39	.50	* 3.00	.57	** 3.59	.49	* 2.84
Design Theory	.36	2.01	.40	2.28	.46	* 2.66	.50	* 3.06	.49	* 2.84
Fashion Design	.44	* 2.55	.51	* 3.06	.56	** 3.52	.52	* 3.16	.43	* 2.49
Clothing	.34	1.86	.40	2.28	.58	** 3.71	.40	* 2.28	.42	2.39

* - 0.05 per cent level of confidence

** - 0.01 per cent level of confidence

Although the t-ratios indicated that the ACE, Otis SA, and Coop C2 were valid for the prediction of academic achievement in certain courses, the inconsistencies in the allocation of marks nullifies the prognostic value of the instruments for City Junior College.

CHAPTER V

CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

1. Restatement of Problem

This study has been made for the purpose of determining the degree of relationship which exists between the scores of the ACE, Otis SA, and Coop C2 and the academic grades received by the freshmen during the college year.

2. Summary of Statistical Procedures

The procedures used were the measures of central tendency, two-way distribution charts, the raw score adaption of the Pearson Product-Moment correlations, Fisher's formula for t-ratios for small samples, and the Null hypothesis.

3. Summary of Findings

The study sample of 93 was composed of 64 Home Economics students and 29 Art, with a mean age of 18.1 years. The test scores of the ACE and Coop C2 showed some negative skewness, the scores of the Otis SA distribution approximated a normal curve. The performance of the Home Economics group was below average on the ACE, the Art group average. The mean intelligence quotient is that of the average college student.

The numerical equivalents of scholastic marks were higher than those of the accepted standards for course grades, causing the distribution to be distorted.

The inter-test correlations of the ACE, Otis SA, and Coop C2 were statistically significant at the one per cent level of confidence. The t-ratios established these tests as valid measurements for the prediction of academic achievement for the study sample.

In the correlations of the tests with course grades in Home Economics, the t-ratios of Chemistry and Hygiene were significant at the one per cent level of confidence with the ACE L score and the Coop C2, respectively. The statistical comparison of the remaining course grades and test scores indicated those individuals who scored below average, average, and above average on the tests did not receive academic marks which were parallel.

For the Art sample, the ACE, Otis SA, and Coop C2 correlated significantly with History of Art, Interior Design, and Fashion Design. The t-ratios of the total ACE and Otis SA scores were significantly related to all course grades. Instructors' marks in Mediums, Drawing, and Design Theory and Coop C2 test scores were statistically correspondent. The significance of the t-ratios at the five and one per cent levels of confidence established the validity of these tests for the prediction of academic achievement of the study sample in certain areas of the Art curriculum. However, without a systematized approach to the assignment of grades, these statistics can be applied, solely, to this study sample.

4. Limitations

This study has been limited by the unorthodox distribution of course grades.

5. Recommendations

The findings of this study suggest investigations and projects of major importance to City Junior College:

1. The investigation, study, and evaluation of curriculums for the purpose of establishing course objectives and outlines.
2. Study and development of a standardized, objective system of grading.
3. The continued study of the relationship between course grades and appropriate standardized tests. Such a project could be used for the validation of teachers' marks.

APPENDIX

TWO-WAY FREQUENCY DISTRIBUTION

of Cumulative Frequencies: Home Economics - ACE Scores

Course Grades: Home Economics

	0-59	60-69	70-79	80-89	90-99	fy
120			3	3	2	8
115			1	7		8
110		1	5	8	2	16
105			4	4		8
100		2	3	9	2	16
95	2	6	4	17	3	32
90	2	4	17	21	12	56
85	2	4	19	33	6	64
80	3	5	15	22	3	48
75		1	17	40	22	80
70	1	3	16	32	4	56
65	2	10	16	13	7	48
60		2	3	3		8
55	2	1	10	17	2	32
50			6	2		8
45	1	2	3	2		8
40	1	5	2			8
35			5	3		8
fx	16	46	149	236	65	512

A
C
E

S
C
O
R
E
S

TWO-WAY FREQUENCY DISTRIBUTION

of Cumulative Frequencies: Art - Otis SA Scores

Course Grades: Art

	0-59	60-69	70-79	80-89	90-99	fy
60		1	9	27	11	48
55			5	25	2	32
50			6	23	3	32
45		8	36	33	3	80
40	2	6	15	9		32
35						
30		1	6	1		8
fx	2	16	77	118	19	232

Table 13. Inter-test Correlations of the Ace, Otis SA, Coop C2 with the corresponding Coefficients of Alienation, Percentages of the Reduction in Errors of Y from X, and Percentages of Variance accounted for.

Tests	Otis SA				Coop C2			
	r_{xy}	k	E	d (100)	r_{xy}	k	E	d (100)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(7)	(8)
Home Economics								
Ace								
Total sc.	.65	.76	24.0	42.0	.63	.78	22.0	40.0
Q score--	.43	.90	10.0	18.0	.32	.94	6.0	10.0
L score--	.60	.80	20.0	36.0	.76	.65	35.0	58.0
Coop C2	.63	.78	22.0	40.0				
Art								
Ace								
Total sc.	.61	.79	21.0	37.0	.62	.78	22.0	38.0
Q score--	.65	.76	24.0	42.0	.58	.81	19.0	34.0
L score--	.58	.81	19.0	34.0	.64	.77	23.0	41.0
Coop C2	.60	.80	20.0	36.0				
Total								
Ace								
Total sc.	.63	.78	22.0	40.0	.65	.76	24.0	42.0
Q score--	.52	.85	15.0	27.0	.40	.92	8.0	16.0
L score--	.55	.84	16.0	30.0	.75	.66	34.0	56.0
Coop C2	.61	.79	24.0	37.0				

k = degree of lack of relationship in contrast with r which equals the strength of the relationship.
 $r^2 + k^2 = 1$ (equation of a circle with a radius of one.)

$k^2 = 1 - r^2$ (the relationship of k to r corresponds to relationship of the sine to the cosine of that angle.)

$k = 1 - r^2$

E = the percentage of reduction of errors of prediction of test Y from test X,

$$\text{SE of } \sigma_{yx} = \sigma_y \sqrt{1 - r_{yx}^2}$$

$$\sigma_{yx} = \sigma_y k_{yx}$$

k(100) = the percentage σ_{yx} is of σ_y

The relationship between the Otis SA and the Coop C2 for the total sample is an r of .61 with k equal to .79, the SE of the estimate is 79 per cent of the observed distributions of the tests. The errors in predicting the Coop C2 scores, when the Otis SA scores are known, is about 79 per cent as great as the errors in the prediction the Coop C2 scores if the Otis SA scores were unknown. In the latter case, every Coop C2 score would be assumed to be the Coop C2 mean score with the σ_y equal to the SE of the predictions. The reduction of the margin of errors equals 100 minus 79 or 21 per cent.

"The index of forecasting efficiency is defined as the percentage reduction in errors of prediction by reason of the correlation between two variables."^{1/}

$$E = 100(1 - \sqrt{1 - r^2})$$

$$E = 100(1 - k)$$

1/J. P. Guilford, pp. 408-411.

$d = r^2$ = the coefficient of determination

$100(d)$ = the percentage of variance in the Coop C2 that is determined by the variance in the Otis SA scores. The r of .61, used in the illustration, indicates that the percentage of variance in the Coop C2 that is accounted for by the variance of the Otis SA is 37 or a little over one-third.^{1/}

1/Adapted from J. P. Guilford, op. cit., pp. 409-411.

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