THE RELATIONSHIP OF CERTAIN MEASURES OF SCHOLASTIC COMPETENCY, AND PREVIOUS SCHOLARSHIP RECORD TO ACHIEVEMENT IN CALCULUS IN THE ENGINEERING SCHOOL AT OKLAHOMA STATE UNIVERSITY

By

DALE EUGENE HASSINGER

Bachelor of Arts
Northwestern State College
Alva, Oklahoma
1942

Master of Music Education
Municipal University of Wichita
Wichita, Kansas
1955

Master of Education
Phillips University
Enid, Oklahoma
1955

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
May, 1961

THE RELATIONSHIP OF CERTAIN MEASURES OF SCHOLASTIC COMPETENCY AND PREVIOUS SCHOLARSHIP RECORD TO ACHIEVEMENT IN CALCULUS IN THE ENGINEERING SCHOOL AT OKLAHOMA STATE UNIVERSITY

Thesis Approved:

Harry K. Brobst
Thesis Adviser

Ira T. Smith

Richard P. Jungen

J. Paschal Twyman

Dean of the Graduate School

PREFACE

During his several years of teaching and administration in Oklahoma schools the writer has been interested in the problems of guiding and counseling high school students. This interest led to the present research which is presented in the hope that it may be used by persons who guide and advise high school students who plan to enter engineering school at Oklahoma State University.

The writer is grateful to Dr. Harry K. Brobst, Chairman of the Advisory Committee, for direction and guidance in this research. The writer wishes to express gratitude and sincere appreciation to the following members of the committee: to Dr. Ida T. Smith for her valuable suggestions and advice, to Dr. Richard Jungers for his advice and encouragement, and to Mr. Paschal Twyman for his most helpful assistance.

To those above, to Mrs. Hassinger and Jane, and to the many other persons who offered encouragement and helpful suggestions, the writer extends his deepest appreciation.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	Nature of the Problem	1
	Purpose of the Study	2
	Scope of the Study	3
	Statement of the Problem	5
	Hypothesis to be Tested	6
	Limitations of the Study	6
	Summary	8
II.	A REVIEW OF RELATED RESEARCH	10
	The Prediction of Scholastic Achievement in College	10
	The Prediction of Scholastic Achievement in Engineering School	12
	Summary	23
III.	DESIGN OF THE STUDY	25
	Subjects of the Study	25
	Sources of Data	27
	Statistical Design	29
	Summary	30
IV.	TREATMENT OF DATA AND ANALYSIS OF RELATIONSHIPS	31
	Treatment of Data	31
	Analysis of Relationships	41
	Summary	50
V.	SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS	53
	Review of the Purpose and Design of the Study	53
	Findings of the Study	54
	Conclusions	55
	Recommendations	57
A SELECTED BIBLIOGRAPHY		58
APPENDIXES		61

LIST OF TABLES

Table		Page
I.	Comparison of Means of Total Scores on ACE for Three Classes Enrolled in Engineering School	26
II.	Intercorrelations Among all Variables Investigated in the Study	33
III.	Prediction of Calculus Grade From ACE Q-score and Average Grade in High School Mathematics	40
IV.	Distribution Table: ACE Q-score and Grade in Calculus	42
V.	Distribution Table: ACE L-score and Grade in Calculus	44
VI.	Distribution Table: Cooperative Algebra Test Score and Grade in Calculus	46
VII.	Distribution Table: High School Mathematics Grade and Grade in Calculus	47
VIII.	Distribution Table: Semesters of High School Mathematics and Grade in Calculus	49

CHAPTER I

INTRODUCTION

Nature of the Problem

Each year many young men enroll as freshmen in engineering schools throughout the United States. Some entrants apparently lack scholastic competencies necessary for the successful completion of a program of study leading to the bachelors degree in engineering as indicated by the number of entrants who do not complete requirements for the degree. A study in which graduation and withdrawal rates were compiled and analyzed for over 13,000 students in engineering schools in the United States was concluded in 1953 by the Educational Testing Service.[1] The findings of the study revealed that 33 per cent of those who entered the program had been graduated from engineering school in four years or had satisfactorily completed four years of a five-year program of study, 11 per cent were still enrolled and were classified as hold-backs, and 56 per cent had withdrawn from engineering school.

Numerous investigations have been conducted for the

---

[1] A. P. Johnson, "Graduation, Hold-back, and Withdrawal Rates in Engineering College," Journal of Engineering Education, XLV (November, 1954), 270-273.

purpose of predicting scholastic achievement in engineering school; nevertheless, student personnel workers continue to conduct research on the prediction of scholastic achievement of engineering students in order that vocational and educational guidance of high school students may be improved.

Records of previous scholarship and measures of scholastic competency are available for use in predicting the scholastic achievement of engineering students; however, a need exists for research relating such records and measures, available at the high school level, to scholastic achievement in calculus in the engineering school curriculum at Oklahoma State University.

Purpose of the Study

The purpose of the present study is to investigate the usefulness of certain objective measures of scholastic competency and of previous scholarship records in predicting scholastic achievement in calculus in the engineering school curriculum at Oklahoma State University.

An examination of student personnel records at the university reveals that approximately 37 per cent of the students who were enrolled as freshmen in the School of Engineering each year from 1950 through 1954 completed successfully the required course of study and were graduated.[2]

---

[2]From information obtained in September, 1958, from Professor Clemmer Wood, Director of Student Personnel, College of Engineering, Oklahoma State University.

This rate corresponds closely with the national average reported in the Educational Testing Service study;[3] therefore, with reference to the survival rate in engineering schools, Oklahoma State University appears to be a typical institution.

The high rate of withdrawal of students from schools of engineering causes unnecessary cost in time, energy, and money to the student and to the university. Research data are needed to enable university personnel to counsel and advise better those seeking admission to engineering schools and to help high school counselors more effectively guide and advise young men who plan to enter engineering schools.

Scope of the Study

The present study is an investigation of the scholarship records and of the scholastic competencies of a selected group of engineering students at Oklahoma State University and a comparison of those records and competencies with success in calculus. The scholarship records that have been investigated for the purpose of the study are those of scholastic achievement in college calculus courses, scholastic achievement in high school mathematics courses, and the number of semesters of high school mathematics courses completed by the students. The scholastic competencies that have been investigated are those of mathematical aptitude,

---

[3]Johnson, pp. 270-273.

verbal aptitude, and proficiency in algebra. The subjects of the study are 122 engineering students who were enrolled in calculus at the university during the 1957-58 school year.

In the study, the approach to the problem of predicting the success of students in engineering school is limited to the prediction of scholastic achievement in a specific subject, calculus, in the engineering school curriculum. This limitation is not intended to imply that achievement in calculus is synonomous with success in engineering school. The writer assumes, however, that the use of scholastic achievement in calculus as a criterion of success in engineering school will provide a more accurate indication of success in the first two years of engineering school than does the average of all grades received in the first two years of engineering school. This assumption is based on the following: the study of calculus involves mathematical understandings not previously presented in the normal sequence of high school mathematics courses; calculus, the final mathematics course in the engineering school curriculum, is probably the most difficult mathematics course in the curriculum; and, according to available records, no subject of the present study had been previously enrolled in a course in calculus.

The writer further assumes that the findings from a number of similar future studies, each using achievement in a different subject matter area or in a different subject in

the engineering school curriculum as a criterion, could be combined and utilized to improve the prediction of success in engineering school. This assumption is based on the tendency, evident in recent studies, to place more emphasis upon the differential nature of the guidance and advisement of students. The approach by Morris is an example of this emphasis:

> Psychologists have long known (1) that different mental processes are required for different subject-matter fields and (2) that individuals differ within themselves as well as among others in utilizing the mental processes they possess.[4]

For these reasons, scholastic achievement in calculus is used in the present study as a criterion of success in engineering school.

Statement of the Problem

A specific statement of the problem of the study may be made as follows: What relationships that will aid in predicting scholastic achievement in calculus exist among certain objective measures of (1) mathematical aptitude, (2) verbal aptitude, (3) proficiency in algebra, (4) scholastic achievement in high school mathematics courses, (5) quantity of high school mathematics courses, and (6) scholastic achievement in calculus?

---

[4] L. H. Morris, "The Relationship Between Certain Factors and Academic Success in College Mathematics" (unpub. Ed. D. dissertation, Oklahoma State University, 1954), p. 1.

The objective measures of the previously stated scholastic competencies and of the scholarship records that have been investigated in the present study are the following:

1. The quantitative portion (Q-score) of the American Council on Education Psychological Examination (a measure of mathematical aptitude);

2. The linguistic portion (L-score) of the American Council on Education Psychological Examination (a measure of verbal aptitude);

3. The American Council on Education Cooperative Algebra Test score (a measure of proficiency in algebra);

4. Grade-point average in high school courses in algebra, geometry, and trigonometry (a measure of scholastic achievement in high school mathematics courses);

5. The number of semesters of high school courses in algebra, geometry, and trigonometry (a measure of the quantity of high school mathematics courses); and

6. Grade-point average in eight semester hours of calculus (a measure of scholastic achievement in college calculus).

Hypothesis to be Tested

The hypothesis of the study, stated in null form, is: No significant relationship exists between any one of the predictive variables listed above and grade-point average in calculus.

Limitations of the Study

Three major limitations are apparent in the present study. One limitation is the number of predictive variables

considered in the study. Many skills, understandings, and attitudes are elements of an individual's general scholastic competency. The prediction of an individual's future success in a given undertaking requires consideration of all elements that may affect the degree of success attained by the individual in the undertaking. Since only five measures of such elements are considered in the study, the possible effect of other elements imposes a limitation on the findings and conclusions of the study.

A second limitation of the study is the use of letter grades as a measure of scholastic achievement in high school mathematics courses and in college mathematics courses. Educators generally agree that letter grades are neither a completely reliable nor a precise measure of scholastic achievement. However, letter grades are used and accepted as a measure of scholastic achievement in most high schools and colleges and are, in most instances, the only measure of scholastic achievement recorded by the teacher. Furthermore, since the present study is designed to investigate the accuracy of the prediction of letter grades, such grades are used in the study despite their inadequacies.

A third limitation of the study is the possible lack of uniformity existing in the previous scholarship records of the subjects of the study. One must assume that variations exist in the quality of instruction, in the subject matter content of high school mathematics courses, and in the prevailing educational philosophies of the high schools

from which the subjects of the study were graduated. Such variations may limit the reliability of the relationships obtained in the study. However, when data from a group of individuals are used in a research study, such variations are reduced, thus providing acceptable measures of group performance. The point is substantiated by Wert, Neidt, and Ahmann:

> The inability to obtain precise measures of human characteristics is a limiting factor whenever the purpose is for counseling an individual, but is a consideration of less importance in research studies involving groups of individuals.[5]

Summary

The research undertaken in the current study is an investigation of the usefulness of certain previous scholarship records and measures of scholastic competency in predicting scholastic achievement in calculus in the engineering school curriculum at Oklahoma State University. The previous scholarship records include grade-point average in high school courses in algebra, geometry, and trigonometry, and the number of semesters of high school courses in algebra, geometry, and trigonometry completed by the subjects of the study. The measures of scholastic competency include the American Council on Education Psychological Examination Q-score, the American Council on

---

[5] J. E. Wert, C. O. Neidt, and J. S. Ahmann, Statistical Methods (New York, 1954), p. 130.

Education Psychological Examination L-score, and the American Council on Education Cooperative Algebra Test score. Grade-point average in eight semester hours of calculus is used as the criterion of success in engineering school for the purpose of the study. The subjects of the study are 122 engineering students who were enrolled in calculus at the university during the 1957-58 school year.

CHAPTER II

A REVIEW OF RELATED RESEARCH

Many studies have been conducted relative to the prediction of scholastic achievement in college. The purpose of the present review is to summarize pertinent findings of selected reports of research that are related to the problem of the present investigation.

The Prediction of Scholastic Achievement in College

Many predictive variables have been investigated to ascertain the relationship of each variable to scholastic achievement. Some variables have been found to be related to scholastic achievement in college; however, few have been demonstrated to be of reliable predictive value.

Carter and McGinnis, at Western Michigan College of Education, conducted a study which is illustrative of the number and kinds of predictive variables related to scholastic achievement in college.[1] The subjects of the study were the one hundred freshmen receiving the highest grade-point average and the one hundred freshmen receiving the

---

[1] H. L. Carter and Dorothy J. McGinnis, "Some Factors Which Differentiate College Freshmen Having Lowest and Highest Point-Hour Ratios," Journal of Educational Research, XLVI (November, 1952), 219-226.

lowest grade-point average in the first year of college. The difference between the two groups of students on each of forty-six different predictive variables considered in the study was investigated to ascertain the effectiveness of each predictive variable in differentiating between the two groups. The reported variables which differentiated significantly between the two groups of students at the one per cent level of confidence are, in descending order of correlation: the average of high school grades, a general scholastic aptitude test, a standardized reading test, a standardized grammar test, an estimate made by the high school principal, a standardized vocabulary test, the number of books reported read, the terms of acceptance by the college, the student's re-entrance in college for the second semester, the number of units failed in high school, the number of periodicals reported read, a definite vocational choice, the student's non-preference for physical education curriculum, and the number of units of credit in high school mathematics.

Garrett reviewed 194 studies of predictive variables related to scholastic achievement in college.[2] The variables reported as having the greatest predictive value are, in descending order of correlation: high school scholarship record, general achievement tests, general college aptitude

---

[2]H. F. Garrett, "A Review and Interpretation of Investigations of Factors Related to Scholastic Success in Colleges of Arts and Sciences and Teachers Colleges," Journal of Experimental Education, XVIII (February, 1949), 91-138.

tests, and special aptitude tests. Garrett further reported that a composite of two predictive variables usually resulted in a higher coefficient of correlation than that obtained with each individual variable. Thus, certain variables have been found to be more effective than others in predicting scholastic achievement in college.

The Prediction of Scholastic Achievement in Engineering School

Many investigators have reported findings of research in the prediction of scholastic achievement in engineering school. The findings indicate the relationship of various measures of scholastic aptitude, scholastic achievement, and previous scholarship record to scholastic achievement in engineering school. These findings demonstrate the use of various measures of scholastic competencies and of previous scholarship records as predictors of scholastic achievement in engineering school, show the relationships obtained between such measures and scholastic achievement in engineering school, and substantiate the selection of the predictive variables considered in the present study.

The predictive value of scholastic aptitude test scores.--Scholastic aptitude test scores have been used extensively as a means of predicting scholastic achievement in engineering schools. The following research findings indicate relationships existing between scholastic aptitude test scores and scholastic achievement in engineering schools.

Dvorak and Salyer, from an investigation of 193 engineering students at the University of Washington, reported a coefficient of correlation of .37 between scores on the University of Washington Intelligence Examination and first year grades in engineering school.[3]

Butsch, from a study of 333 engineering students at Marquette University, reported a coefficient of correlation of .52 between scores on the American Council on Education Psychological Examination and first semester grades in the freshman year of engineering school.[4]

MacPhail compared the effectiveness of the Q and L sub-scores of the American Council on Education Psychological Examination in predicting scholastic achievement in engineering school at Brown University.[5] Using a group of 52 students as subjects, he obtained a coefficient of correlation of .41 between the Q-score and first year grades in engineering school, and a coefficient of correlation of .28 between the L-score and the same criterion.

Wilson and Hodges, from a study of 107 engineering students at the University of Oklahoma, reported a coefficient

---

[3] A. Dvorak and R. C. Salyer, "Significance of Entrance Requirements for the Engineering College at the University of Washington," Journal of Engineering Education, XXIII (April, 1933), 260.

[4] R. L. C. Butsch, "Improving the Prediction of Academic Success Through Differential Weighting," Journal of Educational Psychology, XXX (September, 1939), 405.

[5] A. H. MacPhail, "Q and L Scores on the ACE Psychological Examination," School and Society, LVI (September, 1942), 250.

of correlation of .38 between scores on the Otis Advanced Intelligence Scale and first year grades in engineering school.[6]

Vaughn investigated the effectiveness of the Yale Scholastic Aptitude Test Battery as a predictor of scholastic achievement in engineering school at Newark College of Engineering of Northwestern University and at the Universities of Texas, Tennessee, Florida, and Missouri.[7] The reported data include coefficients of correlation between each test of the battery and first year grades in engineering school: (1) Verbal Comprehension, a correlation of .31; (2) Artificial Language, a correlation of .36; (3) Quantitative Reasoning, a correlation of .50; (4) Spatial Visualizing, a correlation of .38; (5) Mathematical Aptitude, a correlation of .51; and (6) Mechanical Ingenuity, a correlation of .31. The number of cases in the groups studied ranged from 120 to 643.

Dwyer, Horner, and Yoakum reported data from a study conducted at the University of Michigan.[8] The correlation

---

[6] M. O. Wilson and J. H. Hodges, "Predicting Success in the Engineering College," Journal of Applied Psychology, XVI (August, 1932), 349.

[7] L. W. Vaughn, "The Yale Scholastic Aptitude Tests as Predictors of Success in Colleges of Engineering," Journal of Engineering Education, XXXIV (April, 1944), 577.

[8] P. S. Dwyer, C. Horner, and C. S. Yoakum, A Statistical Summary of the Records of Students Entering the University of Michigan as Freshmen in the Decade 1927-1936 (University of Michigan Administrative Studies, Vol. 1, No. 4. [Ann Arbor, 1940]), p. 26.

data between American Council on Education Psychological Examination scores and the average grade received in each year of engineering school are the following: (1) first year grades, eight groups with the number of cases ranging from 187 to 328 with correlations ranging from .35 to .54; (2) second year grades, three groups with the number of cases ranging from 133 to 315 with correlations ranging from .33 to .48; (3) third year grades, one group of 144 cases with a correlation of .35; and (4) fourth year grades, one group of 122 cases with a correlation of .40.

Ritter, in a study of 143 engineering students at Marquette University, investigated the relationship between American Council on Education Psychological Examination scores and grade-point average in the first six quarters of engineering school and reported a coefficient of correlation of .70.[9]

Berdie, from a study of 154 engineering students at the University of Minnesota, reported a relatively low coefficient of correlation of .21 between American Council on Education Psychological Examination scores and first year grade-point average in engineering school.[10]

In summary, in the research of Dvorak and Salyer;

---

[9]R. L. Ritter, "Effective Counseling for Engineering Freshmen," Journal of Engineering Education, XLIV (June, 1954), 638.

[10]R. F. Berdie, "Prediction of College Achievement and Satisfaction," Journal of Applied Psychology, XXVIII (June, 1944), 242.

Butsch; MacPhail; Wilson and Hodges; Vaughn; Dwyer, Horner, and Yoakum; Ritter; and Berdie, as summarized on pages 13-15, scholastic aptitude test scores are compared with grades received in engineering schools. The range of coefficients of correlation reported in the studies cited is from .21 to .70, with a median of .37. Although some of the correlations are relatively high, the stated range of correlations indicates that a test of scholastic aptitude, if used without reference to other measures, is not a reliable basis for the prediction of scholastic achievement in engineering school.[11]

The predictive value of scholastic achievement test scores.-- Scholastic achievement test scores have been used in the prediction of scholastic achievement in engineering schools. The following research findings indicate relationships existing between scholastic achievement test scores in mathematics and scholastic achievement in engineering schools.

Berdie, from a study of 154 engineering freshmen at the University of Minnesota, reported a coefficient of correlation of .45 between scores on the Cooperative Mathematics Test and first year grade-point average in engineering school.

Butsch, from a study of three groups of engineering students at Marquette University, reported the following coefficients of correlation between scores on the Mathematics Section of the Iowa High School Content Examination

---

[11]Ibid., p. 243.

and first semester grades in the freshman year of engineering school: (1) a group of 132 cases with a correlation of .52; (2) a group of 218 cases with a correlation of .56; and (3) a group of 333 cases with a correlation of .57.[12]

Feder and Adler, from a study of 99 engineering students at the State University of Iowa, reported a coefficient of correlation of .72 between scores on the Mathematics Aptitude Test of the Iowa Placement Examination and first semester grade-point average in engineering school.[13]

McGehee, from a study of 383 engineering students at North Carolina State College of Agriculture and Engineering, reported a coefficient of correlation of .50 between scores on the Cooperative Mathematics Test and first year grade-point average in engineering school.[14]

Dwyer, Horner, and Yoakum, from a study of 211 engineering students at the University of Michigan, reported a coefficient of correlation of .39 between scores on the Cooperative Algebra Test and first year grades in engineering school.[15]

---

[12] Butsch, p. 405.

[13] D. D. Feder and D. L. Adler, "Predicting the Scholastic Achievement of Engineering Students," Journal of Engineering Education, XXIX (January, 1939), 381.

[14] W. McGehee, "The Prediction of Differential Achievement in a Technological College," Journal of Applied Psychology, XXVII (February, 1943), 89.

[15] Dwyer, Horner, and Yoakum, p. 26.

In summary, in the research reported by Berdie; Butsch; Feder and Adler; McGehee; and Dwyer, Horner, and Yoakum, as summarized on pages 16-17, scholastic achievement test scores in mathematics are compared with grades received in engineering schools. The range of coefficients of correlation reported in the studies cited is from .39 to .72, with a median of .52. Although the correlations are somewhat higher than those cited in the preceding section on scholastic aptitude test scores, the stated range of correlations indicates that a test of mathematical achievement, if used without reference to other measures, is not a reliable basis for the prediction of scholastic achievement in engineering school.

The predictive value of previous scholarship records.--Previous scholarship records have been used in many studies as a means of predicting the scholastic achievement of engineering students. After a comprehensive survey of the research in the prediction of success in college, Strang came to this conclusion:

> There are three factors which seem to determine scholastic achievement to the greatest extent -- intelligence, previous educative experience, and purpose. The various standard tests of intelligence are probably the best available measure of potential ability, and the achievement and placement tests, of specific preparation. High school marks, in addition to testing these two qualities, may be the best criterion of sustained purpose over a period of years.[16]

---

[16]Ruth Strang, Personal Development and Guidance in College and Secondary School (New York, 1934), p. 235.

The following research findings indicate relationships existing between previous scholarship records and scholastic achievement in engineering schools.

Berdie, from a study of 154 freshmen engineering students at the University of Minnesota, reported a coefficient of correlation of .56 between percentile rank in high school graduating class and first year grades in engineering school.[17]

Dvorak and Salyer, from a study of 333 engineering students at the University of Washington, reported a coefficient of correlation of .50 between the average of all grades received in high school and the average of grades received in the first year of engineering school.[18] From the same study, a coefficient of correlation of .49 was reported between the average of grades received in high school mathematics courses and first year grades in engineering school.

Dwyer, from a study of 1,275 students at the University of Michigan, reported a coefficient of correlation of .42 between the average of high school grades and first year grades in engineering school.[19]

Dwyer, Horner, and Yoakum, from a study of eight groups

---

[17] Berdie, p. 242.

[18] Dvorak and Salyer, p. 260.

[19] P. S. Dwyer, "The Use of Subcorrelation in Determining the Predictive Power of High School Grades," Journal of Educational Psychology, XXVII (December, 1937), 675.

of engineering students at the University of Michigan, reported coefficients of correlation ranging from .37 to .45 between the average of grades received in high school mathematics courses and the average of grades received in the first year of engineering school.[20] The number of cases in the groups ranged from 200 to 296.

Laycock and Hutcheon, from a study of 144 engineering students at the University of Saskatchewan, reported a coefficient of correlation of .61 between the average of grades received in high school and the average of grades received in the first year of engineering school.[21]

In a follow-up study of an extensive testing of high school seniors in Wisconsin, Henmon and Holt investigated the relationship existing between the average of high school grades and the average of first year grades in engineering school with a group of 197 students and reported a coefficient of correlation of .41.[22]

In summary, in the research reported by Berdie; Dvorak and Salyer; Dwyer; Dwyer, Horner, and Yoakum; Laycock and Hutcheon; and Henmon and Holt, as summarized on pages 19-20,

---

[20] Dwyer, Horner, and Yoakum, p. 26.

[21] S. R. Laycock and N. B. Hutcheon, "A Preliminary Investigation Into the Problem of Measuring Engineering Aptitude," Journal of Educational Psychology, XXX (April, 1939), 284.

[22] V. A. C. Henmon and F. O. Holt, A Report on the Administration of Scholastic Aptitude Tests to 34,000 High School Seniors in Wisconsin, 1929-1930 (University of Wisconsin Bulletin No. 1786 /Madison, 1931/), p. 12.

the percentile rank in high school graduating class, the average of grades received in all high school courses, and the average of grades received in high school mathematics courses are compared with grades received in the first semester or in the first year of engineering schools. The over-all range of coefficients of correlation is from .37 to .61, with a median of .49. If one considers only the average of grades received in high school mathematics courses, the range of coefficients of correlation is from .37 to .49, with a median of .45. Although the reported coefficients of correlation are fairly high, the range of such coefficients indicates that a measure of previous scholarship record, if used without reference to other measures, is not a reliable basis for the prediction of scholastic achievement in engineering school.

The predictive value of a composite of variables.--A composite of variables has been used in some studies for the prediction of scholastic achievement in engineering schools. The following research findings indicate relationships existing between various composites of predictive variables and scholastic achievement in engineering schools.

Dvorak and Salyer, from a study of 193 engineering students at the University of Washington, reported a coefficient of multiple correlation of .68 between a composite of predictive variables and first year grade-point average in engineering school.[23] The variables are scores on the

[23]Dvorak and Salyer, p. 260.

University of Washington Intelligence Test; scores on the Mathematics Aptitude and Mathematics Training Tests of the Iowa Placement Examination; and grade-point average in high school courses in English, natural science, social science, and mathematics.

Johnson, from a study of 200 engineering students at Purdue University, reported a coefficient of multiple correlation of .76 between a composite of predictive variables and first year grade-point average in engineering school.[24] The predictive variables are scores on the Mathematics Training Test of the Iowa Placement Examination, scores on the Cooperative Intermediate Algebra Test, scores on the American Council on Education Psychological Examination, the "V" factor of the Thurstone Primary Mental Abilities Test, and rank in high school graduating class.

McGehee, from a study of 383 engineering students at North Carolina State College of Agriculture and Engineering, reported a coefficient of multiple correlation of .57 between a composite of predictive variables and first year grade-point average in engineering school.[25] The predictive variables are scores on the American Council on Education Psychological Examination, scores on the Cooperative English Test, and scores on the Cooperative Mathematics Test.

---

[24] A. P. Johnson, The Prediction of Scholastic Achievement for Freshmen Engineering Students at Purdue University (Purdue University Division of Education Reference Studies in Higher Education, XLIV: Studies in Engineering Education II [Lafayette, 1927), p. 27.

[25] McGehee, p. 89.

In summary, in the research of Dvorak and Salyer, Johnson, and McGehee, as summarized on pages 21-22, scholastic aptitude test scores, scholastic achievement test scores, and previous scholarship records are used as composite variables and are compared with scholastic achievement in engineering schools. The coefficients of multiple correlation range from .57 to .76. The findings indicate that a composite of a scholastic aptitude test score, a scholastic achievement test score, and a measure of previous scholarship record constitutes a moderately reliable basis for the prediction of scholastic achievement in engineering school.

Summary

Scholastic aptitude test scores, scholastic achievement test scores, and previous scholarship records have been used by many investigators as predictive variables related to scholastic achievement in engineering schools. In most of the studies reviewed in the present chapter, first semester or first year grade-point average was used as the criterion of success in engineering school. In one study, grade-point average in each of the four years in engineering school was used as the criterion of success in engineering school.

The extreme range of coefficients of correlation reported between various predictive variables and grades received in engineering school indicates that each

predictive variable, if used without reference to other measures, is not a reliable basis for the prediction of scholastic achievement in engineering schools. However, the research findings indicate that a composite of the variables constitutes a moderately reliable basis for the prediction of scholastic achievement in engineering schools.

CHAPTER III

DESIGN OF THE STUDY

The study is an investigation of the relationships existing between certain objective measures of scholastic competency and of previous scholarship record and the criterion of scholastic achievement in calculus in the engineering school curriculum at Oklahoma State University.

Subjects of the Study

The subjects of the present study are the male students in the College of Engineering of Oklahoma State University who were enrolled in calculus during the 1957-58 school year. Complete data were not available for students from foreign countries or for students who transferred to the university from other institutions. After the writer deleted the names of foreign students and of transferred students from the group, 122 cases remained for whom complete data were available. These 122 students are the subjects of the study.

Approximately 88 per cent of the subjects had been graduated from Oklahoma high schools. There is a moderately uniform distribution of students from the high schools of the state, and both large and small schools are included in

the list of schools. A list of the high schools and the number of students from each school may be found in Appendix A, pp. 62-63.

That the group of students used as subjects in the study is representative in intelligence (as measured by the American Council on Education Psychological Examination) of classes of engineering students who enroll in calculus at the university is shown by examining the significance of the difference between the means of total scores on the examination for the subjects of the study and for each of the two preceding classes of engineering students who enrolled in calculus at the university (1955-56 and 1956-57). The distribution of total scores on the examination for the three classes of students may be found in Appendix B, pp. 64-69. The formulas are from Wert, Neidt, and Ahmann.[1] Table I is a summary of the comparison of the subjects of the study

TABLE I

COMPARISON OF MEANS OF TOTAL SCORES ON ACE FOR THREE CLASSES ENROLLED IN ENGINEERING SCHOOL

Classes	Number of Cases	Mean	Difference	t-value
1957-58 Class (Subjects)	122	101.4	-	-
1956-57 Class	104	101.57	.17	.12
1955-56 Class	164	105.26	3.86	1.83

[1] Wert, Neidt, and Ahmann, p. 132.

with each of the two preceding classes of engineering students. The tabled value of "t" is 1.98 at the five per cent level of confidence for the number of cases considered in the study. Neither of the obtained t-values, .12 and 1.83, equals the tabled value of "t" at the five per cent level of confidence; therefore, the observed differences, .17 and 3.86, between the means of total scores on the American Council on Education Psychological Examination for the three classes of engineering students are not significant. The evidence indicates that the group of students used as subjects in the present study is representative with respect to scores on the examination of classes of engineering students who enroll in calculus at Oklahoma State University.

Sources of Data

Primary data for the subjects included in the study were obtained from permanent records available at Oklahoma State University.

The Bureau of Tests and Measurements of the university had administered the American Council on Education Psychological Examination[2] (hereafter called the ACE) to all the subjects of the study at the time of their first enrollment at the university. Data from the examination were made available by the bureau. The ACE is a measure of the general scholastic aptitude of college freshmen. The

---

[2] Published by Educational Testing Service, Princeton, New Jersey. A revised edition is published annually.

examination consists of two sub-tests: Linguistic (L), which is a measure of vocabulary knowledge and of ability to reason with words; and Quantitative (Q), which is a measure of non-verbal reasoning ability and of skill and speed in solving arithmetic problems.

The mathematics department of the university had administered the American Council on Education Cooperative Algebra Test[3] (hereafter called the Cooperative Algebra Test) to all freshmen students, including all engineering freshmen, enrolling in mathematics courses. The test scores received by the subjects included in the study were obtained from the mathematics department. The Cooperative Algebra Test provides a measure of proficiency in the skills and principles included in elementary algebra through quadratics.

Transcripts, available in the Registrar's office of the university, provided the following data for each subject of the study: credits received in high school mathematics courses, grades received in high school mathematics courses, and grades received in calculus courses at Oklahoma State University.

Test scores and other primary data for the subjects included in the study may be found in Appendix C, pp. 70-79.

---

[3]Published by Educational Testing Service, Princeton, New Jersey. A revised edition is published annually.

Statistical Design

The following brief description of the design of the study is included to provide for the reader an overview of the statistical treatment of the data used in the study.

The first part of the design of the study was the computation of zero order coefficients of correlation among all of the variables used in the study. The Pearson product-moment method of correlation was used, following a formula from Garrett.[4]

The second part of the design was a test of the hypothesis of the study. This was accomplished by the application of the appropriate coefficient of correlation which indicates the degree of relationship existing between each predictive variable and scholastic achievement in calculus.

The third part of the design was the computation of partial and multiple coefficients of correlation between the optimum composite of predictive variables and scholastic achievement in calculus, using formulas from Garrett.[5]

The final part of the design was the formulation of a multiple regression equation, the purpose of which is to

---

[4]Henry E. Garrett, Statistics in Psychology and Education (New York, 1953), p. 142.

[5]Ibid., pp. 378-387.

predict an individual's probable grade in calculus at Oklahoma State University.

Summary

The subjects of the study are 122 engineering students who were enrolled in calculus at Oklahoma State University during the 1957-58 school year. Evidence is presented which indicates that the subject group is representative in intelligence of classes of engineering students who enroll in calculus at the university. The design of the study includes the computation of zero order coefficients of correlation among all variables, a test of the hypothesis of the study, the computation of partial and multiple coefficients of correlation between the optimum composite of variables and the criterion, and the formulation of a multiple regression equation. The results of the statistical computation will be presented in detail in Chapter IV.

CHAPTER IV

TREATMENT OF DATA AND ANALYSIS OF RELATIONSHIPS

The data gathered as described in Chapter III were subjected to the statistical treatment of the design of the study and the results of the statistical treatment were analyzed to make the correlation data more meaningful.

Treatment of Data

The statistical design of the study, described on page 29, includes the following: (1) the computation of zero order coefficients of correlation among all variables used in the study, (2) a test of the hypothesis of the study, (3) the computation of partial and multiple coefficients of correlation between the optimum composite of predictive variables and the criterion, and (4) the formulation of a multiple regression equation that might be used in predicting an individual's probable grade in calculus at Oklahoma State University.

Intercorrelations among all variables used in the study.-- The first part of the design of the study was the computation (using the Pearson product-moment method of correlation) of zero order coefficients of correlation among all of the variables used in the study. The

computations were made following a formula from Garrett.[1] The correlations are presented in Table II.

A correlation of .233 is significant at the one per cent level of confidence, and a correlation of .178 is significant at the five per cent level of confidence for the number of cases considered in the study.[2] In the intercorrelation table, involving fifteen correlations, six correlations are significant at the one per cent level of confidence; one is significant at the five per cent level of confidence; and eight correlations are not sufficiently large to be significant at the five per cent level of confidence, which is the lowest level of confidence acceptable in educational and psychological research.[3]

Although intercorrelations among all of the variables were needed for mathematical computations in the design of the study, only five relationships are pertinent to the discussion of findings at this point in the study. Those pertinent relationships are as follows:

1. The ACE Q-score is most closely related to grade-point average in calculus. The coefficient of correlation is .462, which is significant at the one per cent level of confidence. This correlation is higher than the median of the correlations between scholastic aptitude test scores

---

[1]Henry E. Garrett, p. 142.

[2]Ibid., p. 439.

[3]Ibid., p. 186.

TABLE II

INTERCORRELATIONS AMONG ALL VARIABLES
INVESTIGATED IN THE STUDY

N = 122

Variables		(Refer to Numbered Variables at Left of Table) 1	2	3	4	5	6
	Means	1.82	44.09	57.39	29.85	3.06	5.19
	Sigmas	1.02	9.13	11.06	11.29	.75	1.76
1. Grade-Point Average in Calculus			.462**	.127	.175	.428**	.118
2. ACE Q-score				.494**	.512**	.109	.226*
3. ACE L-score					.287**	-.113	.091
4. Cooperative Algebra Test score						.108	.314**
5. Grade-Point Average in High School Mathematics							-.020
6. Semesters of High School Mathematics							

** Significant at the one per cent level of confidence.
* Significant at the five per cent level of confidence.

and grades received in engineering schools, as reported in the studies reviewed in Chapter II.

2. Grade-point average in high school mathematics courses is also closely related to grade-point average in calculus. The coefficient of correlation is .428, which is significant at the one per cent level of confidence. This correlation is slightly lower than the median of the correlations between high school scholarship records and grades received in engineering schools, as reported in the studies reviewed in Chapter II.

3. The relationship existing between the Cooperative Algebra Test score and grade-point average in calculus is expressed by a coefficient of correlation of .175, which is not significant. This correlation is much lower than the correlations between scholastic achievement test scores in mathematics and grades received in engineering schools, as reported in the studies reviewed in Chapter II. A possible explanation of the inconsistency of this finding of the study is that scholastic achievement in calculus is dependent upon the utilization of mathematical competencies other than, or in addition to, proficiency in algebra.

4. The relationship existing between the ACE L-score and grade-point average in calculus is expressed by a coefficient of correlation of .127, which is not significant. This finding provides evidence that scholastic achievement in calculus is not dependent upon verbal aptitude.

5. The coefficient of correlation obtained between the number of semesters of high school mathematics courses and grade-point average in calculus is .118, which is not significant. This finding provides evidence that scholastic achievement in calculus is not dependent upon the quantity of high school mathematics courses completed by the student.

The coefficient of correlation of .108 obtained between the Cooperative Algebra Test score and grade-point average in high school mathematics courses is much lower than one would expect. The coefficient of correlation of -.020 obtained between the number of semesters of high school mathematics courses and grade-point average in high school mathematics courses is also unusually low. The writer can offer no logical explanation of these two findings of the study. However, since these relationships are outside the scope of the present investigation, they will not be discussed further in the present report.

Test of the hypothesis of the study.-- The second part of the design of the study was a test of the hypothesis of the study. The previously stated hypothesis includes the following sub-hypotheses:

1. No significant relationship exists between the ACE Q-score and grade-point average in calculus,

2. No significant relationship exists between the ACE L-score and grade-point average in calculus,

3. No significant relationship exists between the Cooperative Algebra Test score and grade-point average in calculus,

4. No significant relationship exists between the grade-point average in high school mathematics courses and grade-point average in calculus, and

5. No significant relationship exists between the number of semesters of high school mathematics courses and grade-point average in calculus.

The test of each sub-hypothesis was accomplished by the application of the appropriate coefficient of correlation, tested for significance, which indicates the degree of relationship existing between each predictive variable and the criterion of the study. The findings of the study for the present sample are these:

1. With reference to mathematical aptitude, as measured by the ACE Q-score, the null hypothesis is rejected at the one per cent level of confidence. A significant relationship exists between this measure of mathematical aptitude and the criterion.

2. With reference to verbal aptitude, as measured by the ACE L-score, we fail to reject the null hypothesis. No significant relationship exists between this measure of verbal aptitude and the criterion.

3. With reference to proficiency in high school algebra, as measured by the Cooperative Algebra Test score, we fail to reject the null hypothesis. No significant relationship exists between this measure of proficiency in algebra and the criterion.

4. With reference to scholastic achievement in high school mathematics courses, as measured by grade-point average in high school mathematics courses, the null hypothesis is rejected at the one per cent level of confidence. A significant relationship exists between this measure of scholastic achievement in high school mathematics courses and the criterion.

5. With reference to the quantity of high school mathematics courses, as measured by the number of semesters of high school mathematics courses completed by the student, we fail to reject the null hypothesis. No significant relationship exists between this measure of the quantity of high school mathematics courses and the criterion.

These five findings are applicable to the present sample. Statistical inference may be used in applying the findings to other engineering students at Oklahoma State University. However, no claim of universality is made for the findings.

Relationship between a composite of variables and the criterion.-- In the third part of the design of the study, partial and multiple coefficients of correlation were computed between the optimum composite of predictive variables, ACE Q-score and grade-point average in high school mathematics courses, and the criterion of the study.

The following primary data were used in the calculations:

$N = 122$

(X_1) Grade-Point Average in Calculus	(X_2) ACE Q-score	(X_3) Grade-Point Average in High School Mathematics
$M_1 = 1.82$	$M_2 = 44.09$	$M_3 = 3.06$
$\sigma_1 = 1.02$	$\sigma_2 = 9.13$	$\sigma_3 = .75$
$r_{12} = .462$	$r_{13} = .428$	$r_{23} = .109$

The computations were made following formulas from Garrett.[4] The partial coefficients of correlations and the partial sigmas follow.

[4] Ibid., pp. 378-387.

$r_{12.3} = .466$ $\quad \sigma_{1.23} = .83$

$r_{13.2} = .429$ $\quad \sigma_{2.13} = 7.40$

$r_{23.1} = -.111$ $\quad \sigma_{3.12} = .68$

Calculated from the preceding data, score weights and beta weights are these:

$b_{12.3} = .05$ $\quad \beta_{12.3} = .45$

$b_{13.2} = .52$ $\quad \beta_{13.2} = .38$

The standard error of estimate of the predicted score is derived directly from $\sigma_{1.23}$ and is .83.

Finally, the coefficient of multiple correlation was computed from the preceding data and was found to be this:

$$R_{1(23)} = .58$$

The tabled value of "R" is .275 at the one per cent level of confidence for the number of cases in the study and for the number of variables involved in the computations.[5] The obtained "R," therefore, is significant at the one per cent level of confidence.

The coefficient of partial correlation between the ACE Q-score and the criterion, with the influence of grade-point average in high school mathematics partialled out, is .466. The coefficient of partial correlation between grade-point average in high school mathematics and the criterion, with the influence of the ACE Q-score partialled out, is .429.

The coefficient of multiple correlation between a

---

[5] Ibid., p. 439.

composite of ACE Q-score and grade-point average in high school mathematics courses and the criterion of grade-point average in calculus in .58. This correlation compares favorably with the coefficients of multiple correlation reported in the studies reviewed in Chapter II.

The multiple regression equation.-- The final part of the design of the study was the formulation of a multiple regression equation which might be used as an aid in predicting an individual's grade in calculus at Oklahoma State University. The multiple regression equation in deviation form follows.

$$\bar{x}_1 = .05x_2 + .52x_3$$

Replacing x_1 with $(X_1 - 1.82)$, x_2 with $(X_2 - 44.09)$, and x_3 with $(X_3 - 3.06)$, the equation becomes this:

$$\bar{X}_1 = .05X_2 + .52X_3 - 1.98$$

The values .05 and .52 are the score weights by which the ACE Q-score and grade-point average in high school mathematics courses, respectively, are multiplied. These products and the constant, 1.98, are summed algebraically resulting in $\bar{X}_1$, the predicted grade in calculus.

The accuracy with which it is possible to predict criterion scores using the regression equation is indicated by the standard error of estimate. The standard error of estimate associated with the regression equation is .83. The probability is that in approximately two-thirds of the cases the actual grade in calculus will fall within the

interval of the predicted grade plus or minus the standard error of estimate.

The regression equation appears to be satisfactory for the purpose of advisement of high school students who plan to enter engineering school at Oklahoma State University. The equation may or may not be useful in other institutions.

Table III, which was constructed from the multiple regression equation, may be used to predict a student's grade in calculus from his ACE Q-score and his average

TABLE III

PREDICTION OF CALCULUS GRADE FROM ACE Q-SCORE AND AVERAGE GRADE IN HIGH SCHOOL MATHEMATICS

ACE Q-score	Average Grade in High School Mathematics Courses				
	F	D	C	B	A
80-89	2.27	2.79	3.31	3.83	4.35
70-79	1.77	2.29	2.81	3.33	3.85
60-69	1.27	1.79	2.31	2.83	3.35
50-59	.77	1.29	1.81	2.33	2.85
40-49	.27	.79	1.31	1.83	2.35
30-39	*	.29	.81	1.33	1.85
20-29	*	*	.31	.83	1.35
10-19	*	*	*	.33	.85
0- 9	*	*	*	*	.35

*Below zero.

grade in high school mathematics courses. The use of the table is suggested in a study by Morris.[6] Table III is used by locating the Q-score group in which the student's Q-score falls and the nearest letter representing the student's average grade in high school mathematics courses and by entering the table to locate the predicted calculus grade-point figure. This figure is rounded to the nearest whole number and transmuted to the corresponding letter grade, using the grade-point scale: A = 4, B = 3, C = 2, D = 1, and F = 0. For example, if a student's ACE Q-score is 55 and his average grade in high school mathematics courses is "B," entering the 50-59 row and column "B" gives a calculus grade-point figure of 2.33. Rounded and transmuted, this becomes the letter grade "C." In approximately two-thirds of the cases, this predicted grade will be within .83 grade-points of the actual grade in calculus received at the institution.

Analysis of Relationships

The relationship existing between each predictive variable and the criterion of grade-point average in calculus is analyzed in an effort to make the correlation data more meaningful.

Relationship between ACE Q-score and grade in calculus.-- A study of the data in Table IV shows the

---

[6] Morris, p. 57.

TABLE IV

DISTRIBUTION TABLE: ACE Q-SCORE AND GRADE IN CALCULUS

N = 122

ACE Q-score	Calculus Grade				
	F	D	C	B	A
65-69	0	0	0	1	0
60-64	0	0	1	1	0
55-59	0	2	7	2	0
50-54	5	3	2	5	3
45-49	6	8	13	3	0
40-44	4	5	9	6	1
35-39	6	6	7	1	0
30-34	4	3	1	0	0
25-29	1	0	2	1	0
20-24	1	0	0	0	0
15-19	1	1	0	0	0

distribution of ACE Q-scores in relation to grades received in calculus by the subjects included in the study.

Of the subjects of the study who received ACE Q-scores at or above the mean score (44.09), 82 per cent received a passing grade in calculus, and 18 per cent failed calculus. This means, in terms of probability, that a student who received an ACE Q-score at or above the mean score had approximately eight chances in ten of passing calculus as compared with two chances in ten of failure. The student's

chances were approximately one in two of receiving a grade of "C" or higher, one in four of receiving a grade of "B" or higher, and one in twenty of receiving a grade of "A" in calculus.

Only one student having a Q-score below the mean score received an "A" in calculus, and no student with a Q-score of 55 or higher failed calculus. Further calculation reveals that, of the subjects of the study whose scores were below the first quartile on the score-scale of this portion of the examination, only 26 per cent received a grade of "C" or higher in calculus.

The evidence indicates that a student with a relatively high ACE Q-score will probably receive a passing grade in calculus, and that a student who receives a Q-score below the first quartile on the score-scale of the examination has only one chance in four of receiving a grade of "C" or higher in calculus.

Relationship between ACE L-score and grade in calculus.--A study of the data in Table V shows the distribution of ACE L-scores in relation to grades received in calculus by the subjects of the study.

Of the subjects of the study who received scores at or above the mean score (57.39) on this sub-test of the ACE, 80 per cent received a passing grade in calculus, and 20 per cent failed calculus. This means, in terms of probability, that a student who received an ACE L-score at or above the mean score had approximately eight chances in

TABLE V

DISTRIBUTION TABLE: ACE L-SCORE AND GRADE IN CALCULUS

N = 122

ACE L-score	Calculus Grade				
	F	D	C	B	A
90-94	0	0	1	0	0
85-89	0	0	0	0	0
80-84	0	0	0	0	0
75-79	0	2	2	2	0
70-74	1	1	5	1	0
65-69	1	4	8	4	3
60-64	7	1	4	2	0
55-59	7	6	11	5	0
50-54	6	6	3	1	0
45-49	2	5	4	2	1
40-44	3	2	2	1	0
35-39	1	0	2	1	0
30-34	0	0	0	1	0
25-29	0	0	0	0	0
20-24	0	0	0	0	0
15-19	0	1	0	0	0

ten of passing calculus as compared with two chances in ten of failure. The student's chances were approximately six in ten of receiving a grade of "C" or higher, two in ten of

receiving a grade of "B" or higher, and one in twenty of receiving a grade of "A" in calculus.

If this interpretation were carried no further, the ACE L-score would appear to be of equal value with the ACE Q-score in predicting a student's grade in calculus. Further calculation reveals, however, that 22 per cent of the students having an ACE L-score at or above the mean score received a grade of "B" or higher in calculus, whereas 16 per cent of the students having an ACE L-score below the mean score received a grade of "B" or higher in calculus. Thus, the ACE L-score does not discriminate between success and failure in calculus with the subjects of the present study.

The evidence indicates that the verbal portion of the ACE is of doubtful value as a predictor of scholastic achievement in calculus at Oklahoma State University.

Relationship between Cooperative Algebra Test score and grade in calculus.-- A study of the data in Table VI shows the distribution of Cooperative Algebra Test scores in relation to grades received in calculus by the subjects of the study.

Of the subjects of the study who received scores at or above the mean score (29.85) on the Cooperative Algebra Test, 82 per cent received a passing grade in calculus, and 18 per cent failed calculus. Of the students who scored at or above the mean score on the test, 59 per cent received a grade of "C" or higher, 24 per cent received a grade of

TABLE VI

DISTRIBUTION TABLE: COOPERATIVE ALGEBRA TEST SCORE AND GRADE IN CALCULUS

N = 122

Cooperative Algebra Test Score	Calculus Grade				
	F	D	C	B	A
55-59	0	1	2	0	0
50-54	0	2	0	0	0
45-49	3	0	2	2	1
40-44	1	4	7	1	1
35-39	1	3	6	5	2
30-34	6	4	4	3	0
25-29	5	4	7	4	0
20-24	4	6	6	2	0
15-19	3	3	7	1	0
10-14	4	0	1	1	0
5- 9	1	1	0	1	0

"B" or higher, and 7 per cent received a grade of "A" in calculus. However, of the students who scored below the mean score on the test, 49 per cent received a grade of "C" or higher, 15 per cent received a grade of "B," and none received a grade of "A" in calculus.

If the mean score of the test had been used as a cutting score, 61 per cent of the subjects of the study who failed calculus would have been eliminated from the group. However, almost 50 per cent of the subjects receiving

a grade of "B" in calculus received scores below the mean score and would have also been eliminated from the group.

The evidence indicates that the Cooperative Algebra Test score is of doubtful value as a predictor of scholastic achievement in calculus at Oklahoma State University.

Relationship between high school mathematics grade and grade in calculus.-- A study of the data in Table VII shows, by the distribution of subjects in the various grade categories, the relationship between grade-point average in high school mathematics courses and grades in calculus.

TABLE VII

DISTRIBUTION TABLE: HIGH SCHOOL MATHEMATICS GRADE AND GRADE IN CALCULUS

N = 122

Grade-Point Average in High School Mathematics	Calculus Grade				
	F	D	C	B	A
3.5 - 4.0	8	10	20	12	1
3.0 - 3.4	7	4	5	2	2
2.5 - 2.9	4	7	11	5	1
2.0 - 2.4	6	4	4	1	0
1.5 - 1.9	2	3	2	0	0
1.0 - 1.4	0	0	0	0	0
.5 - .9	1	0	0	0	0

Of the subjects of the study who received an average grade of "C" (2.0) or higher in high school mathematics courses, 78 per cent passed calculus, and 22 per cent failed calculus. In terms of probability, a student with an average grade of "C" or higher in high school mathematics courses had approximately eight chances in ten of passing calculus as compared with two chances in ten of failure. The student's chances were approximately two in five of receiving a grade of "C" or higher, one in five of receiving a grade of "B" or higher, and one in twenty-five of receiving a grade of "A" in calculus.

Of the subjects of the study who received an average grade of less than "C" in high school mathematics courses, none received an "A" or "B" in calculus, and only two received a grade of "C" in calculus.

The evidence suggests that a student with an average grade of less than "C" in high school mathematics courses has one chance in four of receiving a grade of "C" or higher in calculus in the engineering school curriculum at Oklahoma State University.

Relationship between the quantity of high school mathematics courses and grade in calculus.-- A study of the data in Table VIII shows the relationship between the number of semesters of high school mathematics courses and the grade received in calculus by the subjects of the study.

TABLE VIII

DISTRIBUTION TABLE: SEMESTERS OF HIGH SCHOOL MATHEMATICS AND GRADE IN CALCULUS

N = 122

Semesters of High School Mathematics	Calculus Grade				
	F	D	C	B	A
8	3	4	3	3	1
7	2	3	5	0	0
6	7	11	15	8	1
5	2	3	1	1	0
4	11	2	11	7	0
3	1	0	0	0	1
2	2	4	7	1	1

Of the subjects of the study who had completed four or more semesters of high school mathematics courses, 81 per cent passed calculus, and 19 per cent failed calculus. Of the same group of students, 52 per cent received a grade of "C" or higher, 19 per cent received a grade of "B" or higher, and 3 per cent received a grade of "A" in calculus. However, this evidence means very little when compared with the performance of the students who had completed less than four semesters of high school mathematics courses. Of the latter group, 57 per cent received a grade of "C" or higher, 20 per cent received a grade of "B" or higher, and 4 per cent received a grade of "A" in calculus.

The evidence indicates that the number of semesters of high school mathematics courses completed by the student is of doubtful value as a predictor of scholastic achievement in calculus at Oklahoma State University.

Summary

The present chapter contains (1) a summary of the computations followed in the statistical design of the study and (2) an analysis of the relationship existing in the present sample between each predictive variable and the criterion of scholastic achievement in calculus.

The relationship existing between each of the five predictive variables and the criterion of scholastic achievement in calculus is expressed by a zero order coefficient of correlation. The predictive variables and the corresponding coefficients of correlation are these: (1) ACE Q-score, .462; (2) ACE L-score, .127; (3) Cooperative Algebra Test score, .175; (4) grade-point average in high school mathematics courses, .428; and (5) the number of semesters of high school mathematics courses, .118.

The ACE Q-score and grade-point average in high school mathematics courses are closely related to the criterion of scholastic achievement in calculus; the coefficients of correlation are significant at the one per cent level of confidence. The three remaining variables are not significantly correlated with the criterion.

The coefficient of multiple correlation between a composite of ACE Q-score and grade-point average in high school mathematics courses and the criterion of scholastic achievement in calculus is .58, which is significant at the one per cent level of confidence.

The multiple regression equation obtained in the study follows.

$$\bar{X}_1 = .05X_2 + .52X_3 - 1.98$$

X_1 is the predicted grade in calculus, X_2 is a student's ACE Q-score, and X_3 is a student's grade-point average in high school mathematics courses. The standard error of estimate associated with the regression equation is .83.

An analysis of the relationship existing between each predictive variable and the criterion of the study indicates that

1. A student with a relatively high ACE Q-score will probably receive a passing grade in calculus, while a student with a Q-score below the first quartile has only one chance in four of receiving a grade of "C" or higher in calculus.

2. The ACE L-score does not discriminate between success and failure in calculus in the present sample; therefore the ACE L-score is of doubtful value as a predictor of scholastic achievement in calculus.

3. The Cooperative Algebra Test score does not discriminate between success and failure in calculus in the present sample; therefore the Cooperative Algebra test score is of doubtful value as a predictor of scholastic achievement in calculus.

4. A student with a relatively high grade-point average in high school mathematics courses will probably receive a passing grade in calculus. There is only one chance in four that a student with an average grade of less than "C" in high school mathematics courses will receive a grade of "C" or higher in calculus.

5. The number of semesters of high school mathematics courses does not discriminate between success and failure in calculus in the present sample; therefore the number of semesters of high school mathematics courses is of doubtful value as a predictor of scholastic achievement in calculus.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Review of the Purpose and Design of the Study

The purpose of the present study has been to investigate the usefulness of certain objective measures of scholastic competencies and of previous scholarship records in predicting scholastic achievement in calculus in the engineering school curriculum at Oklahoma State University.

The design of the study includes these items: (1) the computation of the zero order coefficient of correlation between each of five predictive variables and the scholastic achievement in calculus of 122 engineering students at Oklahoma State University, (2) a test of the hypothesis of the study, (3) the computation of partial and multiple coefficients of correlation between the optimum composite of predictive variables and the criterion of scholastic achievement in calculus, and (4) the formulation of a multiple regression equation that might be used as an aid in predicting the scholastic achievement in calculus of engineering students at Oklahoma State University.

Findings of the Study

The study is an investigation of the relationships existing among certain objective measures of mathematical aptitude, verbal aptitude, proficiency in algebra, scholastic achievement in high school mathematics, quantity of high school mathematics courses, and scholastic achievement in college calculus. The findings of the study for the present sample follow:

1. The relationship between mathematical aptitude, as measured by the ACE Q-score, and the criterion of scholastic achievement in calculus is expressed by a coefficient of correlation of .462. The coefficient of correlation is significant at the one per cent level of confidence.

2. The relationship between verbal aptitude, as measured by the ACE L-score, and the criterion of scholastic achievement in calculus is expressed by a coefficient of correlation of .127. The coefficient of correlation is not significant.

3. The relationship between proficiency in algebra, as measured by the Cooperative Algebra Test score, and the criterion of scholastic achievement in calculus is expressed by a coefficient of correlation of .175. The coefficient of correlation is not significant.

4. The relationship between scholastic achievement in high school mathematics courses, as measured by the average of grades received in high school mathematics courses, and the criterion of scholastic achievement in

calculus is expressed by a coefficient of correlation of .428. The coefficient of correlation is significant at the one per cent level of confidence.

5. The relationship between the quantity of high school mathematics courses, as measured by the number of semesters of high school mathematics courses completed by the student, and the criterion of scholastic achievement in calculus is expressed by a coefficient of correlation of .118. The coefficient of correlation is not significant.

6. The relationship between a composite of mathematical aptitude and scholastic achievement in high school mathematics courses, as measured in the study, and the criterion of scholastic achievement in calculus is expressed by a coefficient of multiple correlation of .58. The coefficient of multiple correlation is significant at the one per cent level of confidence.

7. The multiple regression equation obtained in the study, using the ACE Q-score and the average of grades received in high school mathematics courses as predictive variables, is $\bar{X}_1 = .05X_2 + .52X_3 - 1.98$. The standard error of estimate associated with the regression equation is .83.

Conclusions

The following conclusions are based on the findings of the present study:

1. A student who receives a relatively high score on the quantitative portion, Q-score, of the American Council on Education Psychological Examination will probably be successful in the study of calculus in the engineering school curriculum at Oklahoma State University, while a student who receives a Q-score below the first quartile has only one chance in four of receiving a grade of "C" or higher in calculus at the university;

2. A student with an average grade of "C" or higher in high school mathematics courses will probably be successful in the study of calculus in the engineering school curriculum at Oklahoma State University, while a student with an average grade of less than "C" in high school mathematics courses has only one chance in four of receiving a grade of "C" or higher in calculus at the university;

3. The ACE L-score, the Cooperative Algebra Test score, and the number of semesters of high school mathematics courses are of doubtful value in predicting scholastic achievement in calculus for engineering students at Oklahoma State University; and

4. A composite of ACE Q-score and grade-point average in high school courses in algebra, geometry, and trigonometry may be used effectively as a predictor of scholastic achievement in calculus for engineering students at Oklahoma State University.

Recommendations

The writer recommends that additional research be conducted with the predictive variables investigated in the present study, comparing these variables with other criteria of success in engineering school. The regression equation obtained in the present study should be investigated with other groups of engineering students to obtain additional evidence concerning the predictive value of the equation.

No mathematical analysis of a single variable or of a composite of variables is completely satisfactory for predicting success in engineering school. However, the prediction of success in engineering school should be based upon something more than random choice; the advisement and guidance of students should be based upon objective data concerning the individual's scholastic competency. The writer offers the results of the present study in the hope that they might be utilized by persons who guide and advise high school students who plan to enter engineering school at Oklahoma State University.

A SELECTED BIBLIOGRAPHY

American Council on Education. Cooperative Algebra Test. Princeton, New Jersey: Educational Testing Service.

_____. Psychological Examination. Princeton, New Jersey: Educational Testing Service.

Berdie, R. F. "Prediction of College Achievement and Satisfaction." Journal of Applied Psychology, XXVIII (June, 1944), 239-245.

Butsch, R. L. C. "Improving the Prediction of Academic Success Through Differential Weighting." Journal of Educational Psychology, XXX (September, 1939), 401-420.

Carter, H. L., and Dorothy J. McGinnis. "Some Factors Which Differentiate College Freshmen Having Lowest and Highest Point-Hour-Ratios." Journal of Educational Research, XLVI (November, 1952), 219-226.

Dvorak, A., and R. C. Salyer. "Significance of Entrance Requirements for the Engineering College at the University of Washington." Journal of Engineering Education, XXIII (April, 1933), 618-623.

Dwyer, P. S. "The Use of Subcorrelation in Determining the Predictive Power of High School Grades." Journal of Educational Psychology, XXVII (December, 1937), 673-680.

_____, C. Horner, and C. S. Yoakum. A Statistical Summary of the Records of Students Entering the University of Michigan as Freshmen in the Decade 1927-1936. University of Michigan Administrative Studies, Vol. 1, No. 4. Ann Arbor, Michigan: 1940.

Feder, D. D., and D. L. Adler. "Predicting the Scholastic Achievement of Engineering Students." Journal of Engineering Education, XXIX (January, 1939), 380-385.

Garrett, H. F. "A Review and Interpretation of Investigations of Factors Related to Scholastic Success in Colleges of Arts and Sciences and Teachers Colleges." Journal of Experimental Education, XVIII (February, 1949), 91-138.

Garrett, Henry E. Statistics in Psychology and Education. New York: Longmans, Green, and Company, 1953.

Henmon, V. A. C., and F. O. Holt. A Report on the Administration of Scholastic Aptitude Tests to 34,000 High School Seniors in Wisconsin. University of Wisconsin Bulletin No. 1786. Madison, Wisconsin: 1931.

Johnson, A. P. "Graduation, Hold-back, and Withdrawal Rates in Engineering Colleges." Journal of Engineering Education, XLV (November, 1954), 270-273.

_____. The Prediction of Scholastic Achievement for Freshmen Engineering Students at Purdue University. Purdue University Division of Education, Reference Studies in Higher Education, XLIV: Studies in Engineering Education II. Lafayette, Indiana: 1942.

Laycock, S. R., and N. B. Hutcheon. "A Preliminary Investigation Into the Problem of Measuring Engineering Aptitude." Journal of Educational Psychology, XXX (April, 1939), 280-288.

MacPhail, A. H. "Q and L Scores on the ACE Psychological Examination." School and Society, LVI (September, 1942), 248-251.

Morris, L. H. "The Relationship Between Certain Factors and Academic Success in College Mathematics." Unpublished Ed. D. dissertation, Oklahoma State University, 1954.

McGehee, W. "The Prediction of Differential Achievement in a Technological College." Journal of Applied Psychology, XXVII (February, 1943), 88-92.

Oklahoma State University. Personal interview with Professor Clemmer Wood, Director of Student Personnel, College of Engineering, Oklahoma State University. September 14, 1958.

Ritter, R. L. "Effective Counseling for Engineering Freshmen." Journal of Engineering Education, XLIV (June, 1954), 636-642.

Ross, C. C. Measurement in Today's Schools. New York: Prentice-Hall, Inc., 1941.

Sarbin, T. R. "The Logic of Prediction in Psychology." Psychological Review, LI (January, 1944), 210-228.

Strang, Ruth. Personal Development and Guidance in College and Secondary School. New York: Harper & Brothers, 1934.

Stuit, D. N., ed. Predicting Success in Professional Schools. Washington, D. C.: American Council on Education, 1949.

Vaughn, L. W. "The Yale Scholastic Aptitude Tests as Predictors of Success in Colleges of Engineering." Journal of Engineering Education, XXXIV (April, 1944), 572-582.

Wert, J. E., C. O. Neidt, and J. S. Ahmann. Statistical Methods in Educational and Psychological Research. New York: Appleton, Century, Crofts, Inc., 1954.

Wilson, M. O., and J. H. Hodges. "Predicting Success in the Engineering College." Journal of Applied Psychology, XVI (August, 1932), 343-357.

A P P E N D I X E S

APPENDIX A

DISTRIBUTION OF SUBJECTS BY HIGH SCHOOLS ATTENDED

School	No. of Subjects	School	No. of Subjects
Oklahoma Schools		Coweta	1
Achille	1	Coyle	1
Amorita	1	Cushing	1
Ardmore	1	Custer	1
Arnett	1	Davidson	1
Baker	1	Del City	1
Balko	1	Dibble	1
Barnsdall	1	Drumright	2
Bartlesville	5	Duncan	2
Beaver	2	Eldorado	1
Billings	2	Elk City	1
Bixby	3	Enid	2
Blackburn	1	Fairview	1
Bokoshe	1	Fargo	1
Bristow	2	Greenfield	1
Broken Arrow	1	Healdton	1
Camargo	1	Heavener	1
Checotah	1	Henryetta	3
Chelsea	1	Hinton	1
Chickasha	1	Hollis	1

APPENDIX A (concluded)

School	No. of Subjects	School	No. of Subjects
Jefferson	2	Shawnee	2
Kendrick	1	Southard	1
Kingfisher	1	Stillwater	1
Kremlin	1	Stonewall	1
Locust Grove	1	Texola	1
Lone Grove	1	Tulsa, Central	5
Manchester	1	Tulsa, Will Rogers	6
Maud	1	Vici	1
Morris	1	Wagoner	1
Muskogee	1	Warren	1
Nash	1	Wilson	1
Oilton	1	Woodward	1
Oklahoma City, Classen	3	Yale	1
Oklahoma City, N.E.	2	Other States	
Okmulgee	1	Arizona	1
Pawnee	1	Arkansas	3
Perry	2	Kansas	3
Ponca City	4	Missouri	2
Putnam City	2	New Mexico	1
Ripley	1	Texas	3
Sapulpa	1	Territorial Schools	
Sayre	1	Canal Zone	1
Seminole	1	Guam	1

APPENDIX B

DISTRIBUTION OF TOTAL SCORES ON ACE FOR SUBJECT GROUP, 1955-56 GROUP, AND 1956-57 GROUP OF ENGINEERING STUDENTS

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
162		1	
161			
160			
159			
158			
157			
156			
155			
154			
153			
152		1	
151		3	
150			
149		2	
148		1	2
147			1
146		1	
145			

APPENDIX B (continued)

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
144		1	
143			
142			
141		2	
140			
139		2	
138			
137			
136	1		
135	1	1	1
134	1		
133			
132	2		1
131			
130		3	1
129	1	1	1
128	2	6	
127	1		
126		3	
125	1	1	1
124	2	3	1
123			2
122	1		1

APPENDIX B (continued)

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
121	1	1	
120	4	4	1
119	1	3	
118	2	3	
117	3	1	
116	2	1	
115	1	1	
114	3	3	1
113	3	4	2
112	2	5	1
111	4	7	9
110	3	2	5
109	3	6	3
108	3	6	2
107	2	1	
106	2	1	
105	4	4	
104	3	3	
103	1	4	1
102	5	5	2
101	2	5	8
100	1	2	8
99	5	4	3

APPENDIX B (continued)

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
98	3	2	8
97	3	1	5
96		1	2
95	1	3	
94	6	1	1
93	1	1	1
92	4	1	3
91	2	3	2
90	1	4	3
89	3	4	6
88	2	5	1
87	1		1
86		4	
85	2	1	
84	1	2	
83			
82	2	2	
81	2	2	
80	4		
79	2	3	
78		1	
77	3	2	1

APPENDIX B (continued)

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
76	1	1	1
75			1
74			3
73		1	
72			
71		1	
70			1
69		4	
68			
67	1	1	
66			1
65	1	1	
64			1
63	1	1	
62			
61			
60			
59			
58			
57			
56			
55		1	
54			

APPENDIX B (concluded)

ACE Total Scores	Frequency		
	Subject Group	1955-56 Group	1956-57 Group
53			
52			
51			
50			
49			
48			
47			
46			
45			
44			
43			
42			
41			
40			
39			
38			
37			
36			
35	1		1
34			1

APPENDIX C

TEST SCORES AND OTHER PRIMARY DATA FOR SUBJECTS OF THE STUDY

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
1	2.0	3.0	33	66	19	2
2	.5	2.0	36	49	32	8
3	2.5	3.5	47	59	23	2
4	1.0	2.7	49	25	32	7
5	3.5	2.7	54	51	34	4
6	1.5	3.8	44	57	23	6
7	1.5	1.5	45	67	37	5
8	2.5	2.8	57	77	43	8
9	1.5	4.0	43	49	34	6
10	2.5	4.0	27	65	22	8
11	2.0	3.7	56	79	43	6
12	1.0	2.0	57	72	55	6

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
13	.5	3.0	52	72	29	5
14	1.0	3.3	16	19	22	4
15	2.0	3.5	47	72	21	2
16	.5	2.8	33	51	22	4
17	.5	3.0	52	62	30	4
18	1.0	2.7	41	69	37	6
19	3.0	3.7	52	57	17	6
20	2.5	3.0	45	67	41	4
21	1.5	3.0	49	59	23	5
22	2.0	2.3	41	36	26	4
23	.5	4.0	44	60	30	6
24	1.0	3.5	47	75	22	2
25	3.5	2.5	56	42	37	6

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
26	2.0	1.5	47	70	39	4
27	2.5	4.0	35	45	31	5
28	1.5	2.7	35	57	32	6
29	2.0	3.3	49	57	31	6
30	.5	2.8	48	66	31	4
31	2.0	3.5	59	73	26	4
32	2.0	3.8	61	59	30	6
33	2.0	2.8	47	64	17	4
34	2.0	2.3	50	55	38	6
35	3.0	3.0	28	35	9	4
36	2.5	3.5	54	66	35	6
37	2.0	3.0	51	56	41	8
38	2.0	2.7	59	54	47	7

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
39	2.5	4.0	44	58	15	2
40	.5	3.8	42	60	22	6
41	2.5	4.0	42	68	37	6
42	3.0	4.0	42	57	31	6
43	2.0	2.0	41	66	19	2
44	.5	1.5	36	41	14	4
45	.5	2.7	51	58	25	6
46	2.0	2.6	57	70	28	7
47	.5	.5	46	63	13	2
48	2.0	4.0	42	47	16	4
49	3.5	3.7	43	61	35	6
50	.5	3.7	43	56	46	7
51	4.0	3.0	54	66	41	6

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
52	3.0	3.5	56	76	38	6
53	1.0	2.2	38	43	27	6
54	2.0	2.5	35	44	16	6
55	.5	2.0	48	56	26	4
56	2.5	3.5	26	56	37	6
57	1.5	1.7	53	75	50	6
58	2.5	3.3	43	46	22	6
59	.5	3.5	22	43	12	6
60	3.0	2.0	50	68	21	6
61	1.0	2.8	56	61	52	6
62	3.5	3.5	44	46	25	4
63	.5	2.5	33	47	15	4
64	4.0	4.0	51	69	35	3

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
65	2.5	4.0	46	70	20	2
66	1.0	2.2	36	51	28	6
67	.5	3.5	52	61	28	4
68	1.5	2.6	38	43	36	8
69	4.0	3.4	53	68	49	8
70	1.0	3.3	33	47	15	4
71	.5	3.0	38	54	49	2
72	.5	3.0	15	37	6	4
73	3.0	4.0	46	71	20	6
74	2.0	2.5	37	57	42	2
75	2.0	4.0	44	92	41	6
76	1.5	3.9	47	67	41	8
77	3.5	4.0	44	56	27	2

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
78	1.0	3.5	52	49	44	4
79	3.0	2.9	43	68	33	8
80	3.5	2.6	67	58	47	8
81	1.5	4.0	41	51	9	2
82	2.0	4.0	58	41	42	6
83	3.0	2.6	49	67	39	5
84	2.0	3.8	36	58	25	4
85	1.0	2.3	48	46	27	7
86	2.0	3.7	47	68	25	6
87	2.0	4.0	42	55	27	4
88	2.0	4.0	35	62	18	4
89	3.0	3.5	62	66	40	4
90	2.5	2.4	40	51	30	7

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
91	1.5	2.8	37	57	18	6
92	2.5	3.1	35	45	48	7
93	.5	2.7	37	56	36	6
94	4.0	2.5	41	47	35	2
95	.5	3.3	45	53	10	4
96	3.5	4.0	51	46	27	4
97	2.0	3.7	48	54	37	6
98	3.0	4.0	47	77	27	4
99	1.0	4.0	33	52	18	2
100	.5	2.0	49	62	40	6
101	2.0	2.5	47	66	16	4
102	.5	1.7	41	53	31	7
103	3.0	3.6	52	58	48	8

APPENDIX C (continued)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
104	1.0	2.7	49	50	34	6
105	3.5	3.7	48	55	41	6
106	.5	2.0	28	51	21	4
107	.5	3.8	34	43	18	5
108	.5	3.0	30	59	26	6
109	1.5	3.6	39	66	24	7
110	.5	3.5	49	59	22	4
111	2.0	2.6	48	63	56	7
112	1.5	3.5	41	54	40	8
113	.5	3.9	35	63	46	8
114	.5	2.1	51	57	31	8
115	3.5	4.0	42	60	37	6
116	1.5	3.8	46	59	25	5

APPENDIX C (concluded)

Case No.	Grade-Point Average in Calculus	Grade-Point Average in High School Mathematics	ACE Q-score	ACE L-score	Cooperative Algebra Test Score	No. Semesters in High School Mathematics
117	2.5	2.5	39	37	12	4
118	2.5	2.5	57	61	55	8
119	.5	3.0	37	51	15	3
120	1.5	1.5	40	51	22	2
121	3.5	3.3	35	32	12	4
122	2.5	1.7	46	56	27	6

VITA

Dale Eugene Hassinger

Candidate for the Degree of

Doctor of Education

Thesis: THE RELATIONSHIP OF CERTAIN MEASURES OF SCHOLASTIC COMPETENCY AND PREVIOUS SCHOLARSHIP RECORD TO ACHIEVEMENT IN CALCULUS IN THE ENGINEERING SCHOOL AT OKLAHOMA STATE UNIVERSITY

Major Field: Educational Administration

Biographical:

Personal data: Born on September 9, 1920 at Capron, Oklahoma.

Education: Attended elementary school in Alva, Oklahoma; graduated from Alva High School in 1938; received the Bachelor of Arts degree from Northwestern State College, Alva, Oklahoma, with a major in Music Education, in May, 1942; received the Master of Music Education degree from the Municipal University of Wichita, Wichita, Kansas, in May, 1955; received the Master of Education degree from Phillips University, Enid, Oklahoma, with a major in Educational Administration, in May, 1955; completed requirements for the Doctor of Education degree in May, 1961.

Professional experience: Taught in the public schools at Guymon, Oklahoma, 1947-48, and at Capron, Oklahoma, 1948-55; was Superintendent of Schools at Manchester, Oklahoma, 1955-59; since 1959 has been Superintendent of Schools at Fort Supply, Oklahoma.

Professional organizations: Phi Delta Kappa, Oklahoma Education Association, Oklahoma Association of School Administrators, and National Association of School Administrators.