AN EVALUATION OF DIFFERENTIAL PREDICTION OF ACADEMIC SUCCESS FOR STUDENTS AT WASHINGTON STATE UNIVERSITY

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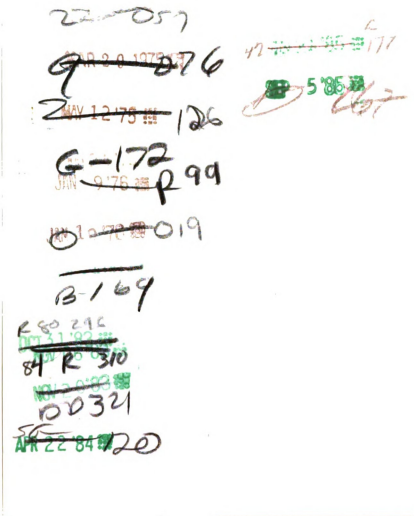

ABSTRACT

AN EVALUATION OF DIFFERENTIAL PREDICTION OF ACADEMIC SUCCESS FOR STUDENTS AT WASHINGTON STATE UNIVERSITY

by Clarence H. Bagley

The purpose of the study was to evaluate for students at Washington State University the grade predictions from the Washington Pre-College Testing Program. The statewide testing program uses a multiple regression approach to the prediction of college grades in academic areas from high school grade averages and scores on aptitude and achievement tests. The evaluation was concerned with (1) the accuracy of the predictions in predicting achieved grades at Washington State University, (2) the determination of existing hierarchies for predicted and achieved grades for the two normative groups at the University of Washington and Washington State University, and (3) a comparison between the predicted grades from the Washington Pre-College Testing Program and similarly developed predicted grades from normative data at Washington State University, when compared with accuracy of predicting achieved grades at Washington State University.

The data in the study were in the form of punched cards or on computer magnetic tape. Existing computer

programs from the testing program, specially developed tabulating programs, and research programs were extensively used in the study. Normative groups for deriving predictions and for comparison purposes were the 1956-1957 freshmen at the University of Washington and the 1958-1960 freshmen at Washington State University. The cross-validity group for comparison of the predictions from the two normative groups was the 1961 freshmen at Washington State University.

The data for the first and second part of the study were developed from regular statistical programs using past operational data. The grade predictions for each student were in 36 criterion or academic areas (chemistry, speech, zoology, etc.), common to Washington State University and previously designated areas of the Washington Pre-College Testing Program. The predictions for both groups used the Iterative Predictor Selection Program for the IBM 709 computer. The Program was developed at the University of Washington and followed the Horst technique for multiple differential prediction. The Program determined for each criterion area a corrected multiple correlation and predictor beta weights.

There were no statistically significant differences among three levels of achieved grades when compared with the predicted grades of the present Washington Pre-College Testing Program. The present predictions can be used to predict cumulative freshmen grades as well as cumulative freshmen-sophomore grades or cumulative freshmen-senior grades.

A rank-correlation coefficient of .88 between the predicted grades for the normative groups of the two institutions showed a definite hierarchy. A rank-correlation coefficient of .57 between the achieved grades showed a greater variation exists in achieved than in the predicted grades. A comparison of the ranking of the predicted grades with the ranking of the achieved grades for the 1961 freshmen at Washington State University showed a rank-correlation coefficient of .57. The hierarchy among the predicted and achieved grades reflects the concept of differential prediction and demonstrates the differences in grading practices of departments within the university.

The predictions derived from multiple iteration procedures of the criteria of achieved grades of students at Washington State University did not improve the correlations to achieved grades over the predicted grades from the Washington Pre-College Testing Program except for the criterion areas of architecture, art, biology, engineering, forestry, geology, journalism, pharmacy, and physics. The prediction formulas now used in the state-wide testing program need not be changed for students at Washington State University except as noted.

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THE PROBLEM

Introduction

A continually increasing college-age population and an ever-rising number of students are subjecting American colleges and universities to unprecedented enrollment pressures. Modern technology and a rapidly changing world are demanding greater numbers of quality graduates in every field. More students and parents are seeing higher education as necessary for achieving success in a complex society. But with limited money and physical facilities, college administrators are faced with the formidable task of satisfying the quantitative and qualitative demands of an education-minded populace.

From 1900 to 1963, college enrollments increased from 250,000 to 4,100,000,[1] and the total number of students is expected to increase even more rapidly in the future. The question is, then: "How can the present limited resources and facilities of colleges and universities provide for the forecast increase in students?" These limitations are

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[1] Statistical Abstracts of the United States, 84th annual edition (Washington: U.S. Government Printing Office, 1963), p. 114.

already causing colleges and universities to be more selective in their enrollment procedures. This, in turn, is creating more pressure on the confused college students of the future. Admission procedures vary greatly among institutions, and it is imperative that the successful student be given proper guidance before and after entering college.

Differences in admission requirements and the great variation in quality and content of the curriculum demonstrate the uniqueness of each institution's educational environment. These differences, coupled with the range of student abilities and the diversity of high school academic training, bewilder students. Consequently, institutions of higher education must, collectively and individually, determine the best policy for admissions and, more important, must strive to create the best academic climate for each student.

The selection of students is the result of many variables, not all of which are easily measured. Motivation and personality variables are not sufficiently understood, and progress toward their understanding suffers from inadequate research design and lack of empirical data. Other variables such as faculty size and classroom facilities may be more easily measured, yet their impact on learning effectiveness and subsequent grades is difficult to ascertain. The methods of measuring the student's accomplishment in college are, therefore, often invalid and unreliable.

Faculty and student services personnel in institutions of higher education must obtain the best possible estimate of student potential and student limitations in order to provide effective guidance and counseling programs for today's students. Institutions must develop a more reliable method for selecting applicants, a more efficient test for evaluating the qualities of college environment, and a greater proficiency in determining the educational skills developed by each student. In 1954 Del. Wolfe made the following statement, which is particularly applicable to higher education today.

> Improved programs of student guidance, founded upon better manpower information and better methods of appraising an individual's aptitudes will enable more young people to make choices which are best for them, and for the nation, and thus constitute an important element in a total effort to secure better use of the nation's intellectual resources.[1]

The total guidance program, which includes not only academic advising and professional counseling, but also testing and prediction, is an important source of information for determining student needs. An admissions officer considers carefully the past academic records and test information gathered on each student. However, admission to an institution of higher learning should be considered as only the first step in a student's educational experience. During his university years the student is confronted with

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[1]Deal Wolfe, America's Resources of Specialized Talent (New York: Harper & Brother, 1954), p. 280.

a myriad of academic and social problems. If he is to profit from his college experience, more guidance and testing are often necessary. A student may switch majors several times before he finds one suitable to his talents; a change in universities is sometimes in order; or there is a re-defining of educational goals. Some students will benefit from one year of university work, although they may not complete the undergraduate course work. In some cases, a student may be directed primarily to graduation or to a post-baccalaureate education. To meet these varied situations effectively, counseling, testing, and prediction are important to the student. The process of prediction becomes a day-to-day reality of research and selection on the educational, military, or industrial scene, where the emphasis is on the best utilization of human resources.

The success of the student in a college cannot and should not be predicted wholly by the process of aptitude and achievement testing, nor can it be interpreted other than in the context of the individual and his environment. However, test data play a significant part in any selection or admissions program involving prediction.

There are widely divergent opinions concerning the use of prediction and of psychological testing in the areas of guidance and counseling. One historical viewpoint was a complete rejection of predictions and testing, as in individual therapy as presented in Rogers' earlier books, in contrast to the view of the dedicated trait-and-factor

person of the early 1940's.[1] Advocates of the moderate position, which combines the use of psychometric data with other aspects of the counseling or advising program, state: "Tests are valuable in the extent to which they improve the accuracy of inescapable judgments."[2] Thus, the controversy as to whether or not psychological tests can be used for prediction involves consideration of the tests and the prediction criteria.

Inasmuch as it involves error of measurement and probability, prediction in individual guidance practices should be in accordance with statistical rationale.

Tyler summarizes the use of tests for prediction work by stating:

> It is because all existing aptitude tests make these errors in prediction that reputable psychologists in counseling positions refuse to let final decisions as to what individuals should do with their lives rest on tests alone. Since limitations vary from test to test, the task of drawing valid conclusions from a combination of several of them presents complex problems.[3]

Thus, modern statistical theory, data processing machines and computers, and trained and informed guidance and counseling staffs have contributed to the increased use of prediction and testing in the academic setting.

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[1]Carl Rogers, Client Centered Therapy (New York: Houghton-Mifflin Company, 1951), p. 220.

[2]John G. Darley and Gordon V. Anderson, "The Functions of Measurement in Counseling," E. R. Lindquest (ed.), Educational Measurement (Washington, D.C.: American Council on Education, 1951), p. 76.

[3]Leona E. Tyler, The Psychology of Human Differences (Boston: Appleton-Century Crofts, Incorporated, 1956), p. 133.

Need for the Study

The year 1960 marked a significant change in the use of testing data for placement, admissions, and academic prediction of grades at Washington State University. A change in the evaluation for admission of high school seniors and the formulation of a different and distinctive freshman testing program created an awareness of the need for more research in the area of prediction of academic success. Increased concern by the university resulted in a new admissions policy which used test data and high school records and thereby made a more systematic program of testing necessary.

With the initial use of the Washington Pre-College Testing Program as a required prerequisite for admission to Washington State University in 1960, the former freshman orientation testing program was eliminated in favor of the more feasible pre-college testing program. The Washington Pre-College Testing Program is a state-wide program supported by and involving 25 of the 29 colleges and universities and all the high schools in the state. The program uses as its governing board the Council on High School-College Relations. The primary function of the program is to provide test data for counseling and guidance of the high school senior as well as for the college freshmen. Evolving from the former University of Washington Differential Guidance Program, it uses multiple regression analysis for predicting college grades in various academic areas.

The transition in 1960, from the former program under the University of Washington to that of a state-wide testing program, exposed for many a need to evaluate the testing program. It was necessary to examine the accuracy of the test data for prediction, placement, and counseling. It was also necessary to determine the cross-validity of the statistical procedures used in the new state-wide testing program, as well as to compare the differences in the normative groups.

The diversity of the educational programs offered by institutions of higher learning in Washington and the increasing quality and quantity of the student body challenged the effectiveness of using one set of testing norms for all students and all colleges in the state. Multiple predictions of college grades from test scores and high school grades needed more specific study.

Other state institutions have raised their high school grade-point entrance requirements from 2.0 to 2.5. This change was necessitated by the overcrowding of school facilities and by the realization that students with less than a 2.5 high school grade-point average have a limited chance of succeeding at these institutions.[1] State colleges are studying the wisdom of current admission standards in an effort to determine the probable effect of such changes.

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[1]Ad Hoc Committee to Study the Freshman Year, "A Progress Report," University Admission Policy, University of Washington, Seattle, February 25, 1960.

The high school senior, as well as the college freshman, is interested in the collegiate freshman year and its subsequent academic demands. For many students the first year of college is, academically, a "make or break"situation. For other students it represents the only college training that they will receive. Is one year of college sufficient for some, or must all students be encouraged to graduate? Can a student lead a successful life in our present society without a college diploma? The increasing emphasis upon the problem of ascertaining the probable success of a student in college is, therefore, desirable in a quality testing program.

At Washington State University about 30 percent of the entering freshmen leave school before the beginning of their second year, and many more approach their sophomore year with low grades. Those interested in a more effective counseling procedure and appropriate admissions criteria are concerned with grade prediction in different academic areas, as well as a general level of achievement by students.

The faculty and staff of Washington State University believes that a student should be admitted to the university if he has a reasonable chance of success. The term "reasonable chance of success" is interpreted to mean a completion of the freshman year with a grade-point average of 2.0 or higher, with 4.0 equaling A. The use of prediction data should apply especially to the freshman year, since this is the crucial time for determining a student's academic

ability. The freshman year is critical to the student who is faced with the task of determining the specific major most suited to him, and of selecting the necessary classes and instructors. The former testing program at Washington State University did not include differential prediction of academic success. The prediction data of the present Washington Pre-College Testing Program, using as a criterion the accumulative four years of collegiate grades in the academic areas, may not accurately predict freshman grades at Washington State University. Therefore, a careful appraisal of a program for the prediction of academic grades would be useful in the evaluation of the student potential necessary to achieve during the freshman year as well as the remaining academic career. High school students, their parents, and counselors would benefit from such a study. Predictions that could be applied to the freshman year would serve as an intermediate step toward the final decision of a major during and after the freshman year.

The differences found in the test scores of the present group of students, in relationship to their academic work at Washington State University, and the 1955 freshman group at the University of Washington who are used in the normative data for the Washington Pre-College Testing Program, may be significant or negligible for the purpose of this study. No valid evidence has previously been shown to prove any hypothesis of differences or similarities.

Purpose of the Study

It has been previously stated that the Washington Pre-College Testing Program was developed through research conducted at the University of Washington. Initially, all the necessary data for the program were based on University of Washington students. The actual collegiate grades earned by students at the University of Washington were used with multiple regression analysis to derive the predicted grades in the Washington Pre-College Testing Program.

The question pertinent to this study is whether a prediction from the Washington Pre-College Testing Program for a certain grade-point average in a definite major within the college curriculum relates specifically to the student taking course work at Washington State University. Are the multiple regression formulas, beta weights, and multiple R's now used in the computation of predictions with the state-wide testing program also applicable to another university's population?

Specifically:

1. As measured by high school grades and testing data on the Washington Pre-College Testing Program, are there wide differences in students' aptitudes and achievements between students at Washington State University and students in the University of Washington's normative group?

2. How accurate are the current predicted grades of the Washington Pre-College Testing Program for students at Washington State University at various levels of progress,

i.e., freshman, sophomore, or senior? Can the grade predictions be used to predict grades equally well at all three levels?

3. Is there a hierarchy of predicted and achieved grades from the Washington Pre-College Testing Program and what similarity does this hierarchy have to the predicted and achieved grades for students at Washington State University?

4. Are the present predictor equations used in the Washington Pre-College Testing Program valid for Washington State University students, or should predictor equations be based on the grades achieved by students at Washington State University?

Limitations of the Study

This study does not directly reflect the part that motivation and interest play in academic achievement. Recognizing the effect of these two variables and the difficulty of their measurement, the study is restricted to an examination of those predictor variables now used in the Washington Pre-College Testing Program. The variables of motivation and interest are reflected in high school achievement and thus are indirectly considered in the prediction formulas. Certain areas, such as music and art, may require skills or abilities not measured by the Washington Pre-College Testing Program, but again the study is restricted to the use of presented predictor variables.

A second limitation of the study is the sample sizes for the predictor correlations and the criterion correlations. The elective nature of the curriculum results in a disparity in the number of type of students in the various criterion areas. Ideally, the criterion groups should be students with identical programs selected as random samples of a total group. However, the selection of course work by the students in the samples is not random, and thus small samples are produced where an unknown and, therefore, immeasurable amount of sampling error may arise. The resulting sample should, therefore, have separate symmetric matrices for each regression formula, since there is a difference in the size of the criterion sample.

The study assumes that the criterion groups were representative of the total group, as does the underlying rationale for the Washington Pre-College Testing Program.

The names of the criterion areas, reflecting the appropriate academic titles, such as history, chemistry, etc., do not convey all the essential differences in course content, grading patterns as affected by the instructor, or possible differences in required attributes necessary to attain a particular grade. The variations within a single criterion area, related to the content, grades, and attitude of the students, are largely inferred.

The criterion areas are named to correspond with those names given in catalogs which are issued by the two universities involved in the study.

Overview of Remainder of Thesis

In Chapter I the need for the study was presented and the specific questions regarding the validity of the predicted grades for the Washington Pre-College Testing Program were stated. In Chapter II the review of related literature is presented. The sources of data, procedure for the computer processing, and outlined procedure for the study are given in Chapter III. The evaluation and interpretation of data regarding the four questions given in Chapter I are presented in Chapter IV. The summary and conclusions for the study are presented in Chapter V.

CHAPTER II

REVIEW OF RELATED LITERATURE

The continually increasing college-age population, and consequently higher enrollment figures for institutions of higher education, has emphasized the need for a more selective admissions policy and for accurate prediction of academic success for each individual. The increased use of psychological testing and other prediction data has resulted in numerous studies of the validity of testing instruments and methodology and the subsequent accuracy of the resulting predictions. The desire for better and more diversified testing programs with a reduction of duplication has prompted the public, as well as the educator, to demand a more systematic program of testing.

The use of tests in the selection of applicants for admission and the prediction of academic success, defined in terms of college grades, has been the most explored topic in educational-psychological research. Segal had summarized the findings of 23 studies before 1933.[1] Garrett, in his 1949 review, covering nearly two decades, mentioned

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[1]David Segal, Prediction of Success in College. United States Department of Interior, Office of Education, Bulletin No. 18, Washington. Government Printing Office, 1934.

approximately 194 studies.[1] Fishman reported 580 studies in the years 1950-1958.[2] Travers, who cited more than 200 prediction studies in his review, concluded that high school grades are the best single predictor of college success.[3] Data from a summary by Fishman demonstrated that the classification of the various studies was limited primarily to a global prediction of either a semester grade-point average or the freshman-year grade-point average.[4]

These summaries of studies illustrate (1) that the progress toward improved prediction has been slight despite the many studies which have been made, (2) that most of the present studies follow the pattern of past studies, that is, a global prediction of grades from intellectual factors, and (3) that the development of better predictors and criteria must be concerned with measuring different factors with different data.

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[1]Harley 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, 18:91-131, December, 1949.

[2]Joshua A. Fishman, "Unsolved Criterion Problems in the Selection of College Students," Harvard Educational Review, 28:320-29, Fall, 1958.

[3]Robert M. W. Travers, "The Prediction of Achievement," School and Society, 70:293, November, 1959.

[4]Joshua A. Fishman and Ann K. Pasanella, "College Admission-Selection Studies," Review of Educational Research, 30:298-310, 1960.

Multiple Prediction

Although earlier studies attempted to predict academic success through the use of a single variable (usually standardized tests) a review of studies related to the prediction of academic achievement in college indicates that there is a distinct superiority in multi-variable prediction in comparison with prediction by the use of a single factor. More recently the emphasis in educational guidance and prediction has been on the use of a combination of variables in a carefully integrated battery.[1]

Bruce summarizes the past research by stating:

> Since the early twenties well over 1,000 studies have been made in an attempt to better understand and cope with the problems of university admissions and failures. About 90 percent of these studies used one variable and calculated zero order coefficients or correlations to determine evidence of predictive value of these variables. Approximately 5 percent of the studies combined two variables and computed multiple coefficients of correlation. Some increase in the multiple coefficient or correlation was achieved by investigators using three-variables combinations but only some twenty of such studies have been completed. About eight studies attempted four or more variables with limited success, but rarely does anyone attempt as many as eight independent variables.[2]

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[1] Benjamin S. Bloom and Frank R. Peters, The Use of Academic Prediction Scales (New York: The Free Press of Glencoe, Inc., 1961), p. 37.

[2] William J. Bruce, "The Contribution of Eleven Variables to the Prognosis of Academic Success in Eight Areas at the University of Washington" (unpublished Doctor's dissertation, University of Washington, Seattle, 1953), p. 12.

In 1943 Cosand summarized studies of multiple predictors which showed a range of .53 to .83 with a median of .63. He believed that the multiple predictors with these correlations pointed out the advantage of several rather than a single predictor.[1]

Durflinger reported in 1953 that the multiple correlations, found in summarizing studies, were between .60 and .70 and concluded that the use of several predictors results in the highest multiple R's.[2]

Harris reported the results of combining variables in a review of significant studies which showed the multiple approach superior to a single predictor.[3]

Segal summarized: "It will be noted that coefficients using a combination of items are higher than those given for single predictive items as given previously."[4]

Multiple Differential Prediction of College Grades

Predictors in multiple correlation studies of college grades were primarily intellective and used aptitude or

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[1]Joseph P. Cosand, "Admissions Criteria: A Report to the California Committee for the Study of Education," College and University, 28:338-364, April, 1953.

[2]G. W. Durflinger, "The Prediction of College Success: A Summary of Recent Finding," The American Association of College Registrars Journal, XIV (October, 1943), 68-78.

[3]Daniel Harris, "Factors Affecting College Grades: A Review of the Literature, 1930-37," Psychological Bulletin, 37:125-26, March, 1940.

[4]Segal, op. cit., p. 127.

achievement tests in combination with high school grades or rank in class. Non-intellectual predictors have been used recently, but these have not produced significantly higher multiple correlations.[1] The highest multiple correlations were obtained in the southwest and western colleges, where selective procedures were either so new, or so restricted by statute, that applicant talent was not restricted in ranges.[2] In contrast, the selection procedures studies in other areas resulted in lower multiple correlations. In certain testing programs, where the range of test scores and high school grades was restricted due to a rigid selection system, the size of the multiple correlation coefficient was considerably reduced.[3]

The acceptance of multiple correlation techniques has led to the problem of criteria used in prediction and selection studies. With the advent of high-speed data processing equipment and computer technology, the researcher can obtain more comparative information concerning grade-point averages. Notwithstanding the criticism of the grade-point as a criterion of academic success, it still serves

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[1]Joshua A. Fishman, op. cit., p. 346.

[2]John Spencer Carlson and Victor Milstein, "The Relation of Certain Aspects of High School Performance to Academic Success in College," College and University, 33:185-92, Winter, 1958.

[3]John L. Holland, "The Prediction of Scholastic Success for a High Aptitude Sample," School and Society, 86:290-293, June, 1958.

as the best evidence available.[1] The use of a grade-point average as a criterion for prediction reduces the problem to a question of what criteria to study and what prediction model to use.

When predicting college success as represented by grades in various subjects, one should make a specific prediction of success in the academic areas in accordance with accepted curriculum separations and empirical research. Differences in curriculums and institutions point to the importance of differential prediction of success within each university as well as among colleges and universities. Differential prediction of success in different academic areas, based on experimental work, and given to the student in data form, is a valid procedure. Certainly, each specific or general ability of each student should be studied carefully in order to provide the maximum information concerning each individual's potential in a wide range of subjects.

The reason for using differential prediction is to maximize the potential of the individual in the choice of curriculum as well as to facilitate selection of the best possible candidates. Also, the multi-dimensional character of students, colleges, and curriculums requires a more careful and systematic approach to selection than is possible

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[1]Paul Heist and Harold Webster, "Differential Characteristics of Student Bodies--Implications for Selection and Study of Undergraduates in Conference on Selection and Educational Differentiation," Selection and Educational Differentiation, p. 91-106, Berkeley, California, The Center for the Study of Higher Education, 1960.

with a single criterion. The prediction of success in college by using the criteria of college grades is one step to a more helpful program. The prediction of college grades will be dependent upon the individual variation that exists in the student and the college.

The question then becomes whether criterion should be based on over-all success for each student or whether it should be based on success in each individual course area. One practical difference between the global approach and a more sophisticated differential prediction is the economy involved in the necessary time and money needed to summarize grades within the academic setting.

Over 95 percent of the studies located by Fishman were of the global type in methods and goals.[1] The criteria for these studies were measurements represented by a total grade product, primarily the freshman-year average or the first-semester grade average. The separation of grades by academic-year or subject-matter area was not attempted and the problem of grade prediction or expectancy was not pursued. Many of the prediction studies have been made using essentially the same methods, thus resulting in a standardization of criteria.

Some current research is attempting to expand the global prediction to more definitive subject-matter areas. Crawford and Burnham reported differences between correlations of test scores and freshman marks in various subjects.

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[1] Fishman, op. cit., p. 341.

Correlations range from + .57 to - .01 for two freshman populations. The SAT verbal score correlates with the average grades in English and history + .49 and with physics grades + .40. When achievement tests were used instead of grades, the correlations with aptitude tests tended to be higher, but the pattern of differences remained the same.[1] Stone reviewed the predictions of college grades in broadly defined curriculum areas by using test scores and high school grades. The underlying rationale of this study, then, was to determine if the criterion of college grades would lend itself to differential prediction along curriculum lines.[2]

Statistical Models for Multiple Prediction

The type of differential prediction used in this study is multiple regression or correlation analysis. In contrast, there are other models of differential prediction. Multiple discriminant analysis has been extensively investigated at Harvard by Rulon[3] and Tiedeman.[4] This approach

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[1]A. B. Crawford and P. S. Burnham, Forecasting College Achievement (New Haven: Yale University Press, 1946), 291 pp.

[2]J. B. Stone, "Differential Prediction of Academic Success at Brigham Young University," The Journal of Applied Psychology, 38:109-110, April, 1954.

[3]P. J. Rulon, "Distinction between Discriminant and Regression Analyses and a Geometric Interpretation of the Discriminant Function," Harvard Educational Review, 21:80-90, Spring, 1951.

[4]David V. Tiedeman, "The Multiple Discriminant Function--A Symposium," Harvard Educational Review, 21: 167-186, Spring, 1951.

involves the study of differences in groups defined a priori for those variables held in common. The discriminate function in this approach maximizes the ratio of the variance among groups in relation to the variance within the groups. These workers feel that the discriminant function is a promising method for comparing an individual's scores with those of the groups that he is considering joining. Tyler favors the type of measurement which seeks to characterize the individual's customary pattern of choice rather than the test score.[1] French disagrees. He notes that the discriminant method tells only which group one is similar to, when most persons want to know the degree of success or satisfaction that can be expressed within the group.[2] Thus, while helpful, the discriminant function does not make as thorough a differential prediction as the multiple regression approach to test score analysis.

Pattern analysis and joint regression with a discriminant function, as seen in the work of Fricke and Tatsuoka, are variations attempting to bridge the gap between discriminant function and multiple regression analysis.[3,4]

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[1]L. E. Tyler, "Toward A Workable Psychology of Individuality," American Psychologist, 14:75-81, 1959.

[2]J. W. French, The Logic of and Assumptions Underlying Differential Testing. Proceedings 1955 Invitational Conference on Testing Problems. Princeton, New Jersey, Educational Testing Service, pp. 40-48.

[3]Benno G. Fricke, "A Coded Profile Method for Predicting Achievement," Educational and Psychological Measurement, 17:98-104, Spring, 1957.

[4]Maurice M. Tatsuoka, "Joining Probability of Membership and Success in a Group: An Index Which Combines the Information From Discriminant and Regression Analysis as

Cronbach and Gleser presented a review of more simplified techniques in combining pattern analysis and profile analysis.[1] However, these techniques have not found wide acceptance in testing or research programs.

The use of the multiple regression model for differential prediction makes it necessary to clarify the terms comparative prediction and differential prediction as they are used in the literature, and in the terms multiple absolute prediction and multiple differential prediction. Differential prediction attempts to foresee a difference between the success one individual will have on two criteria, while comparative prediction endeavors to establish the absolute levels of each single criterion. Tucker suggested the term comparative prediction while Mollenkopf introduces the problem of differential prediction.[2] The computations for these two techniques are similar; for a given battery of tests there is no essential difference between the two since the predicted differences are equal to the difference in the predictions. However, the two techniques differ in their selection of predictor variables, since a test yielding high correlations with each of two criteria contributed

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Applied to the Guidance Problem," Harvard Studies in Career Development, No. 6, Harvard Graduate School of Education, October, 1957. (Mimeographed.)

[1] L. J. Cronbach and G. C. Gleser, "Assessing Similarity Between Profiles," Psychological Bulletin, 50:456-473, 1953.

[2] W. G. Mollenkopf, "Some Aspects of the Problem of Differential Prediction," Educational and Psychological Measurement, 12:39-44, 1952.

little to the prediction of differences between the criteria.[1] Still, neither differential nor comparative prediction will provide effective discrimination if the criterion areas are highly correlated. This high correlation between criterion areas makes it exceedingly difficult to differentiate between certain academic subject-matter areas within the university's curriculum. Wesman and Bennett write:

> The tests which survive attempts to predict criterion differences directly are naturally enough those which correlate with those differences . . . . A scholastic aptitude test may be one of our best predictors of success in courses in a liberal arts college; but because that aptitude is very important to success in all courses taken by the freshmen, it will receive little or no weight in the prediction of differences in course grades. Success in each course may depend to a large extent on that aptitude measured by the test, while predictable differences in success may be the product of other characteristics or traits. Tests of these other characteristics or traits will receive greatest weight in the direct prediction of differences.[2]

Michael states that for differential prediction:

> The problem posed was to select a specified number of predictors from several available ones that would yield simultaneously the most nearly accurate prediction of differences between scores on all possible pairs of criterion variables within a given set. For multiple absolute prediction, an attempt was made to select a given number of predictors such that the degree of accuracy with which all of the criterion variables are predicted will be at a

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[1] Paul R. Dressel, A Report on Differential Prediction and Placement in Colleges and Universities (New York: College Entrance Examination Board, 1959), 17 pp. (Mimeographed.)

[2] A. G. Wesman and G. K. Bennett, "Problems of Differential Prediction," Educational and Psychological Measurement, 11:265-272, 1951.

> maximum irrespective of the extent to which the chosen battery differentiates among the various criterion measures.[1]

Horst has discussed the effectiveness of multiple absolute prediction, which has a goal of yielding the highest possible correlations with several criteria.[2,3] In contrast, multiple differential prediction has the goal of yielding the greatest possible differentiation between criteria.[4] The operational implementation of both methods was reported. Zeigler, Bernreuter, and Ford have somewhat similar goals but apply individual procedures to obtain their results.[5] The results of these four methods of analyses can justify reducing the terms comparative prediction, multiple absolute prediction, multiple differential prediction and differential prediction to two terms, multiple differential and multiple absolute. Multiple prediction is, then, a choice between two distinct approaches,

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[1]W. B. Michael, "Development of Statistical Methods Especially Useful in Test Construction and Evaluation," Review of Educational Research, 29:89-109, 1959.

[2]Paul Horst, "Differential Prediction in College Admissions," College Board Review, 33:19-23, Fall, 1957.

[3]Paul Horst, "A Technique for the Development of a Multiple Absolute Prediction Battery," Psychological Monographs, Vol. 69, No. 5, Whole No. 390, 1955.

[4]Paul Horst, "A Technique for the Development of a Differential Prediction," Psychological Monographs: General and Applied, Vol. 68, No. 9, Whole No. 380, Washington, D.C.: American Psychological Association, 1954, p. 31.

[5]Martin L. Zeigler, Robert G. Bernreuter, and Donald H. Ford, "A New Profile for Interpreting Academic Abilities," Educational and Psychological Measurement, 18:583-88, Autumn, 1958.

differential and absolute. The literature refers to overlapping terms given to both methods and does not clearly differentiate between the approaches. However, for this study, multiple prediction refers to differential prediction between criteria as was initially theorized by Horst but not realized operationally in the prediction formula found in the Washington Pre-College Testing Program.

Multiple Differential Prediction at the University of Washington

In 1930 Brammell advocated an approach to multiple differential prediction by recommending a combination of criteria in predicting student success. This initial study, which was written under the direction of August Dvorak, was the first of many studies to investigate multiple variables.[1] Blair and Salyer broadened the consideration of entrance requirements and criteria of success.[2,3] The Angell, Langton, Meyer, and Pettit investigations in 1950 initiated a serious approach to multiple prediction of

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[1]P. R. Brammell, "A Study of Entrance Requirements at the University of Washington" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1930).

[2]Glenn M. Blair, "The Prediction of Freshmen Success in the University of Washington" (unpublished Master's thesis, University of Washington, Seattle, 1931).

[3]Rufus C. Salyer, "An Investigation in the Prediction of Success in the School of Engineering at the University of Washington" (unpublished Master's thesis, University of Washington, Seattle, 1931).

criterion areas using multi-variable factors.[1] These investigators proposed to evaluate individual success in 26 university subject-matter areas by using multiple regression equations, following a simplification of the Yule method of partial correlation as developed by Dvorak.[2] Using this Yule method of correlation and the then new IBM 650 computer, which increased the efficiency factor even more, these investigators reduced the formidable task of multiple prediction calculations. Horst developed his technique to be used with the computer so that the formidable problem of calculations could be done in a few minutes.[3] The progress made in the reduction of calculation time and the expansion of work toward a greater range in criterion areas was complementary to the development of theoretical models, computational methods, and statistical procedures, as well as the use of normative groups for valid studies.

The first statistical rationale reported by Horst in 1950 utilized a technique suitable for the prediction of a single criteria.[4] Two alternate methods were then proposed

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[1]M. A. Angell, R. C. Langton, G. A. Meyer and M. A. Pettit, "An Evaluation of General and Specific Admission Requirements at the University of Washington" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1950).

[2]G. Udny Yule, "On the Theory of Correlation," Journal of the Royal Statistical Society, London, 60:835-838, December, 1897.

[3]Paul Horst, "A Technique for the Development of a Differential Prediction Battery," Psychological Monographs, loc. cit.

[4]Paul Horst and Stevenson Smith, "The Discrimination of Two Racial Samples," Psychometrika, 15:271-289, September, 1950.

to permit the selection of a single battery of predictors from a much larger initial battery, meanwhile maximizing the effectiveness of specific predictions within each criteria.[1] The first rationale was multiple absolute prediction, designed with a sub-set of the original predictors which would yield the "best" prediction of each criterion.[2] The second rationale, multiple differential prediction, was used to select a sub-set of the original prediction battery which would yield optimum predictions of differences in achievement for all possible pairs of criteria. The purpose of multiple differential prediction was to predict the area or areas in which the student would be most successful without regard to his potential level of achievement.[3] The basic research in the development of these two models has been conducted at the University of Washington.

Washington Pre-College Testing Program

The original prediction battery selected for the Washington Grade Prediction Program and, subsequently, the Washington Pre-College Testing Program, was based on the academic performance of the 1949 freshmen who entered the

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[1] William M. Meredith, "Cumulative Calculations of Regression Constants," Multiple Prediction Studies, Office of Naval Research Contract Nonr-477 (08), Paul Horst, principle investigator (unpublished report, The University of Washington, Seattle, June, 1956), p. 1-2. (Mimeographed.)

[2] Paul Horst, "A Technique for the Development of a Multiple Absolute Prediction Battery," Psychological Monographs, Vol. 69, No. 5, Whole No. 390, 1955.

[3] Horst, op. cit. passim.

University of Washington. This battery was "selected" from a larger battery by the Horst's Differential Predictor Selection Technique.[1] The sample criteria were grade-point averages for the 1949 freshmen for the eleven quarters of study ending with the winter quarter of 1953. Grades were analyzed in 32 separate subject areas--anthropology, architecture, art, biology, botany, business administration, chemistry, drama, economics, education, engineering, English, Far Eastern studies, foreign languages, forestry, geography, geology, history, home economics, journalism, mathematics, music, nursing, pharmacy, philosophy, physical education, physics, political science, psychology, sociology, speech, zoology--and in terms of an all-University average.

Fifteen of the original sixteen selected predictor variables used in the differential model in 1953 were also used in the present (1957) battery, with only the Guilford-Zimmerman test of numerical operations eliminated. Mills reviewed the history and development of the differential prediction batteries used at the University of Washington.[2]

Recent studies have continued to investigate multiple variable differential prediction. Long,[3]

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[1]Horst, "A Technique for the Development of a Differential Prediction Battery," Psychological Monograms, loc. cit.

[2]D. F. Mills, "An Interative Selection of Variables for Predicting Certain Criteria of Academic Success at the University of Washington" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1957).

[3]James R. Long, "Academic Forecasting in the Technical-Vocational High School Subjects at West Seattle High School," (unpublished Doctor's Dissertation, University of Washington, Seattle, 1957).

Franks,[1] Mattrick,[2] and Horst[3] suggest that differential predictions of levels of future scholastic achievement can be developed. The state-wide adoption of the Washington Pre-College Testing Program in 1960 was an application of these studies. Two studies by Reas and Lounsberry, have since initiated a comparison of predictions of grade achievement between two institutions.

Reas concluded:

> 1. On the basis of predictor data for entering freshmen at the University of Washington and entering freshmen at Seattle University, the two groups were markedly similar in mean high school grades and mean test scores. On the basis of mean predicted grades in various college subjects, the two groups exhibited small differences.
>
> 2. The correlations between predicted grades and achieved grades of students in corresponding departments in the two universities were very similar. . . . When the difference between students' predicted and achieved grade-point averages in corresponding areas at the two universities were compiled for each tenth of a grade-point difference and plotted, the compilations were so similar and the plotted curves so overlapped each other that without appropriate labels, identification would have been impossible.

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[1]Dean K. Franks, "A Study of the Success of West Seattle High School Students in Languate Arts, Foreign Language, Social Studies, and Music and Art" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1958).

[2]William E. Mattrick, "A Study of the Contributions of Twelve Variables to Prediction of Academic Success in Five Ninth Grade Subjects" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1958).

[3]Horst, "Relationship between Preadmission Variables and Success in College," Office of Naval Research Contract Nonr-477 (08), and Public Health Research Grant M-743 (c3), Paul Horst, Principle investigator (unpublished report, The University of Washington, Seattle, June, 1959). (Mimeographed.)

> 3. When the multiple correlation coefficients, predictor beta weights, and regression equations for Seattle University student data were compared with those developed on the University of Washington student data and currently used in the state-wide program, it was found that the similarities outweighed the differences. . . .[1]

Lounesberry found that a close relationship existed between the educational and grading standards at Western Washington State College and the University of Washington, and that the predictions from both schools were similarly accurate. He concluded that a group of predictors developed from data at one institution can be used with comparable accuracy at a second institution.[2]

Summary

A review of studies related to prediction of academic achievement in college indicated that there is a distinct superiority in the use of multi-variable predictors compared with the use of a single factor. The value of some r's for prediction was between .35 and .83, with a mean correlation value of r = .50.

Predictions were made using the accumulated grade-point average and the freshman year grade-point average as

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[1]Herbert D. Reas, "A Follow-Up Study of the Washington Pre-College Differential Guidance Test at Seattle University" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1962).

[2]James Rodney Lounesberry, "An Evaluation of the Accuracy of the Differential Prediction Test Battery in Predicting Grades for Students at Western Washington State College" (unpublished Doctor's Dissertation, University of Washington, Seattle, 1962).

the criteria. There were few studies related to grade predictions in specific academic areas. Until the development of computer techniques for minimizing calculations and processing large amounts of data, the clerical work proved to be a formidable task.

A review was made of the development of statistical theories for use in multiple prediction and multiple differential prediction at the University of Washington. The application of the differential prediction model was made to the statistical theory underlying the development of the Washington Pre-College Testing Program.

CHAPTER III

SOURCES OF DATA AND METHOD OF PROCEDURE

Sources of Data

Students used in this study were the 1958-1961 freshman class members at Washington State University for whom a complete and valid record of entrance battery test scores of the Washington Pre-College Testing Program was available. These students had been awarded at least one or more grades in regular classes at Washington State University. All students were regularly enrolled and were resident students of the state. All were high school students immediately before entering college.

A sample copy of the data sheet from the test battery, which was given to the students, is presented in Figure 1. The data consist of raw test scores and high school grades as well as predicted college grade-point averages. The identification of the variables used in the state-wide test battery is presented in Table 1. Fifteen of these variables were used for prediction in the Washington Pre-College Testing Program.

The criterion variables include grade-point averages earned by the student in each subject-matter area during his undergraduate tenure at Washington State University.

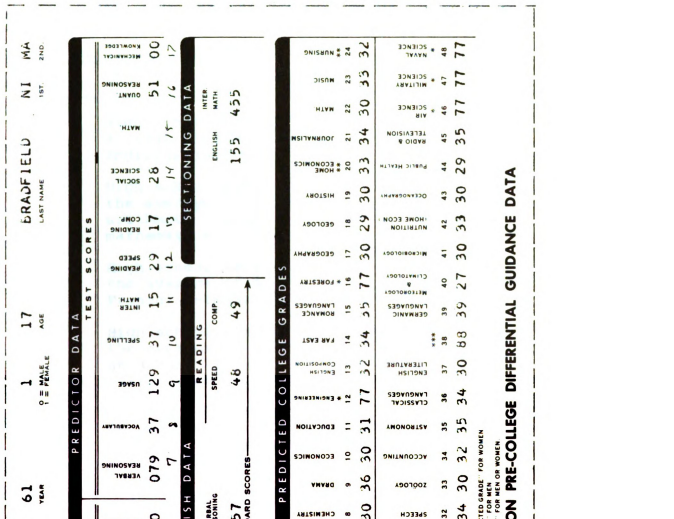

Figure 1. Data sheet from Washington Pre-College Testing Program.

Table 1. Identification of the predictor variables constituting the test scores and high school grade averages employed in this study.

Variable	
1	High school English grade-point average: the average of grades earned in courses such as English, journalism, and speech.
2	High school mathematics grade-point average: the average of grades earned in algebra, business arithmetic, geometry, trigonometry and advanced mathematics courses.
3	High school foreign language grade-point average: the average of grades earned in courses such as French, German, Latin and Spanish.
4	High school social science grade-point average: the average of grades earned in civics, eonomics, geography, psychology, sociology, United States history, and world history.
5	High school natural science grade-point average: the average of grades earned in biology, chemistry, physics, physiology, and in some cases, health education.
6	High school electives (non-academic) grade-point average: the average of grades earned in subject areas such as art, business administration, home economics, music, and manual arts. This average does not include grades from courses such as physical education, driver training, study hall, stage crew, and other courses of non-scholastic content.
7	Guilford-Zimmerman Aptitude Survey, Form A, Part I, Verbal Comprehension: primarily a vocabulary test which requires an understanding of word and concept meanings.
8	Guilford-Zimmerman Aptitude Survey, Form A, Part VII, Mechanical Knowledge: a survey of knowledge of the functions of tools commonly used in the home, for repairing automobiles, or in one of the trades such as carpentry or plumbing.
9	Educational Testing Services Cooperative English Test, Form OM, Part I, English Usage: a test of the ability to recognize and correct errors in grammar and diction, punctuation, capitalization and sentence structure.

Table 1. Continued.

Variable	
10	ETS Cooperative English Test, Form OM, Part II, Spelling: a test of the ability to recognize the misspelled word in groups of five words.
11	ACE Cooperative General Achievement Test, Form X, Section III, Mathematics, Part I, Terms and Concepts: requires understanding of ideas and detection of logical errors in quantitative and spatial concepts.
12	ACE Cooperative General Achievement Test, Form X, Section I, Social Studies, Part II, Comprehension and Interpretation: requires the interpretation of readings, charts, and tables as well as the definition of terms and concepts relevant to different social science areas. It tests the ability to understand the central thought and important details in a passage, to draw inferences from the passage, and to appraise it critically in order to detect contradictions, bias, and irrelevant data.
13	ACE Psychological Examination, 1948 Edition, Quantitative Reasoning Score: includes problems involving number series, figure analogies, and arithmetic.
14	Age: chronological age.
15	Sex: a designation of either male or female.
16	ACE Psychological Examination, 1948 Edition, Linguistic Score: primarily a test of verbal (rather than "school learned") abilities which consist of subtests involving verbal analogies, vocabulary completion types of items, and same-opposites.
17	Cooperative English Test, Text C2, Reading Speed, Higher Level, Form Z: a test to answer questions directly or indirectly related to reading of paragraphs.
18	Cooperative English Test, Test C2, Reading Comprehension, Higher Level, Form Z: a check of accuracy of reading paragraphs and interpreting questions concerning such paragraphs.

These grade-point averages are summarized at three levels--cumulative freshman, cumulative freshman and sophomore, and total grade-point average. These data were obtained from records in the Office of the Registrar.

Criterion Areas

The preparation of the computer tape record of the criterion area grades used in this study followed a summarization procedure as given in a computer program developed at the University of Washington and modified for use at Washington State University.[1] The program summarized a grade-point average for each student in a specified criterion area, or subject-matter area, and indicated the number of credit hours taken. The grade-point averages were calculated regardless of a student's credit hours, so that a 3.0 grade point for 2.0 credit hours was recorded in the same way as a 3.0 grade point for 35.0 credit hours. A cumulative grade-point average was calculated, at the end of the freshman year, for the freshman and sophomore years, and at the end of the senior year. The classification of the curriculum into appropriate criterion areas and the number of students in each is shown in Table 2.

The grades were recorded and averaged for Washington State University students with the freshman of 1958-1960

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[1] Gil Atkinson, "An IBM 709 Grade Summarization Program," IBM Type 709 Program Library Report, Seattle, Division of Counseling & Testing Services, 34 pp (ditto).

Table 2. Number of students constituting each of the original criteria groups.

Subject Area	No. Cases	Subject Area	No. Cases
All University	2293	Geography	572
Accounting	292	Geology	589
Anthropology	862	History	961
Architecture	74	Journalism	101
Art	608	**Home Economics	320
Bacteriology	499	**Nutrition	164
Biology	543	Mathematics	1246
Botany	402	Music	472
Business Administration	365	**Nursing	58
Chemistry	1042	Philosophy	545
Economics	742	Pharmacy	30
Drama	133	Physics	233
Education	647	Political Science	644
*Engineering	427	Psychology	1516
English Composition	391	Radio & TV	59
English Literature	879	Sociology	1541
Languages	344	Speech	657
*Forestry	64	Zoology	749

*Males Only.

**Females Only.

as Group No. 1 and the 1961 freshmen as Group No. 2. The study teminated with the spring semester of 1964. Thus, for each group of students, except the 1961 freshmen, all four years of academic study were recorded. For the 1961 freshmen only three years of records were available for use. Previous studies at the University of Washington reported little differences between achieved grades which had been summarized at the junior or the senior level.[1]

The criterion areas defined are those common to both the University of Washington, as developed and used in the Washington Pre-College Testing Program, and to Washington State University. Reasonable care was taken to determine that matching criterion areas were identical.

The procedure for summarization of the grade point averages in the study followed that used at the University of Washington and in the Washington Pre-College Testing Program, since the purpose of the study was to assess the validity of the grade predictions made from the criterion areas at Washington State University and those at the University of Washington.

Procedure for Study

The data used in this study were either processed on IBM cards or processed by computers using magnetic tape,

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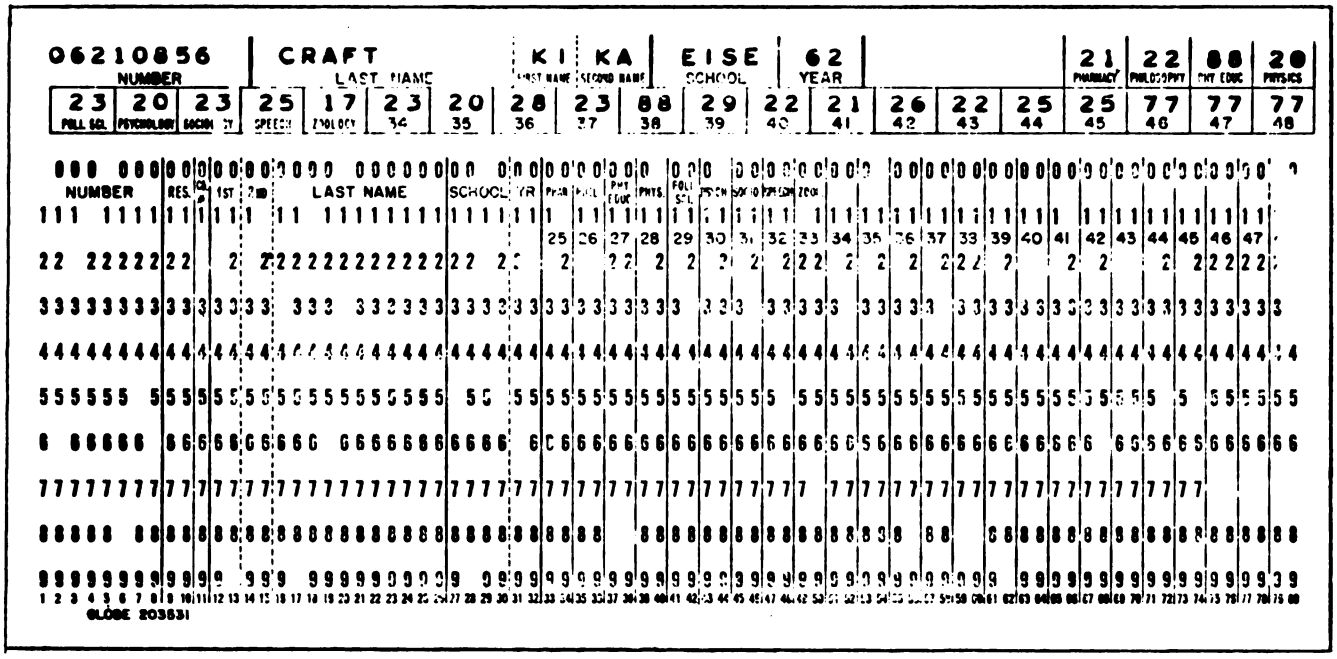
[1]Paul Horst, Differential Prediction of Academic Success. Technical Report, Office of Naval Research Contract Nonr-477 (08), University of Washington Division of Counseling and Testing Services, May, 1959.

thereby collating and arranging the data economically for computer processing. Each student's predictor data, his raw test scores and high school grades, and his predicted college grade points, as presented on the Washington Pre-College Testing Program data sheet, needed only minor changes to be suitable for the study. These data were already on IBM cards and had been used previously to print the data sheet sent to the student. Three cards were taken from the files for each student's data: the entrance card, prediction card No. 1, and prediction card No. 2. These cards are presented in Figure 2. A special mark sense card, with the student's Washington State University identification number, which had already been punched, was then marked by clerical help with the state-wide testing program identification number, processed by the IBM reproducer punch, then collated with the entrance and prediction cards. The mark sense card then contained the identification number for each of the two systems to be used in securing data, the state-wide testing system for the predictor variables and predicted grades, and the university system for obtaining the achieved college grade.

The placing of the garde-card records on computer magnetic tape was initiated in 1962 when the Office of Institutional Research implemented a university system of records in which the entire grade records for all students were placed on tape each semester. These records began with the 1958 fall semester. The records were arranged by



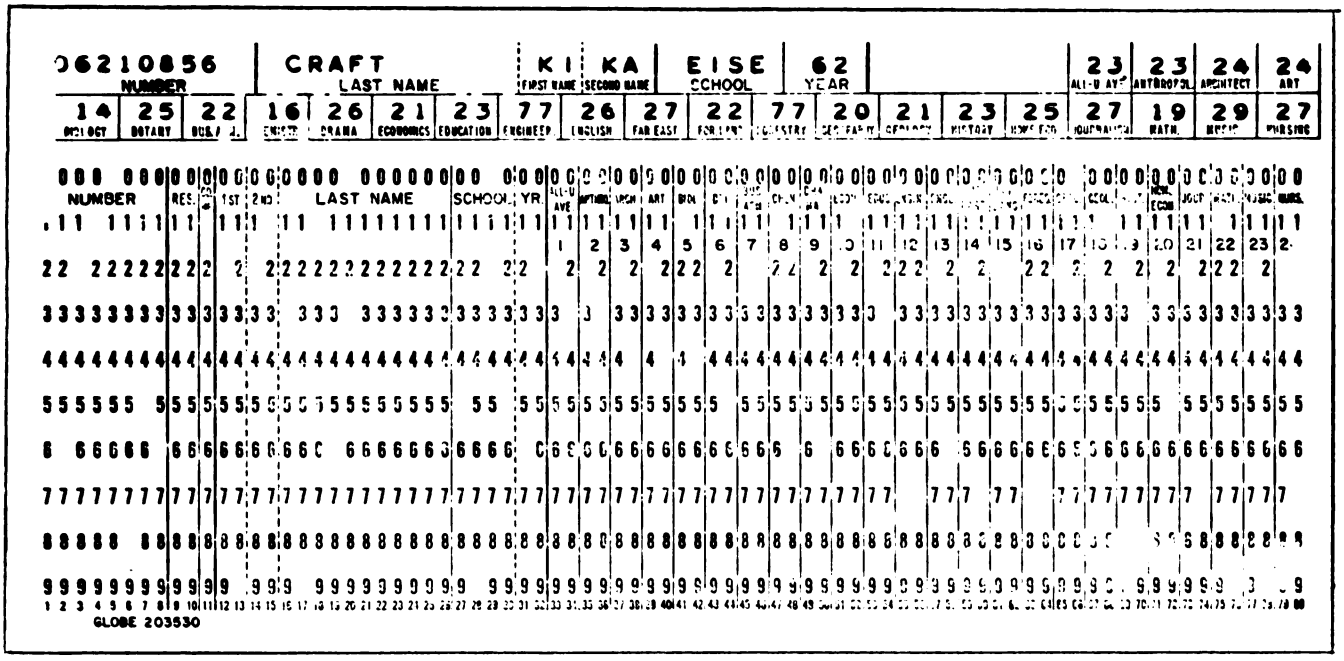


Figure 2. IBM cards from Washington Pre-College Testing Program.

University identification number and followed a standard blocking system whereby one tape contained all grades for one semester. The grades were recorded following the standard format of the actual IBM card containing the recorded grades.

A computer program for the IBM 1401 was used to place the grade records for those students included in the study on a master tape which accurately recorded all the data.[1] Records that did not match or were incorrectly identified were corrected and entered later on the master tape file.

In this study Group No. 1, which is composed of students entering Washington State University in the fall of 1958, 1959 and 1960, was used as the initial sample from which multiple regression data was formulated, using the grades from the Washington State University criterion areas. Group 2 contains the predictor data for students entering Washington State University in the fall of 1961 and was used as the cross-validity sample to check the prediction efficiency of the grade predictions from the Washington Pre-College Testing Program and secondly, the grade predictions made from data derived from Group 1.

The 36 criterion areas used in the study were retained even though 5 areas registered below 100 individual students. Walley reported that a greater amount of variance

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[1]James E. Thummell, An IBM 1401 Computer Program for Grade Summarization at Washington State University.

in multiple correlation problems is accounted for as the number of cases is increased up to 100, with gains then becoming more gradual.[1]

In computing grade-point averages, each credit hour of A was valued at four grade points, each credit hour of B at three grade points, C at two, D at one, and E at zero. Incompletes (I) and withdrawals (W) were not recorded directly and thus were not included in determination of the grade-point average. Grades in military science and physical education activity courses were excluded in computing the all-university grade-point average.

Computation of Intercorrelation and Validity Coefficient Matrices

Computation of intercorrelations and validity coefficients was made by using the standard programs for the IBM 709 computer.[2] The symmetric predictor intercorrelation matrix was made from tape records of the entrance data cards of the 1958-1960 Group 1 freshmen. There were 18 predictor variables in this operation. The non-symmetric criterion correlation coefficient matrices were calculated by using SHARE program 215 on the IBM 709. This program gave the means, standard deviations, and variances for all 18 variables as well as the zero order correlation coefficients between

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[1]Donivan Walley, "Factors that Influence the Selection of Predictor Variable in Multiple Regression," College and University, 1963, 39:72-76.

[2]IBM 709 Correlation Matric Program, Washington State University.

the predictors and grade-point averages in the 36 criterion areas.[1]

The Horst multiple regression, or iteration method, was used for the computation of the corrected multiple correlation coefficients (R's) between the predictors and the criteria of students' achieved grades for the criterion areas at Washington State University.[2] The Horst method simultaneously computed the beta weights (B's) of the predictors which consisted of successive approximations of the contribution of each independent predictor variable to the dependent criterion variable. The iteration procedure selected in sequence the predictors, which, when combined, yielded the largest corrected multiple correlation (Rc) with the criterion. The iteration method selected the highest value in the predictor-criterion vector, which was used to multiply each element in the corresponding vector of the predictor intercorrelation matrix. The products obtained were subtracted from their corresponding correlations in the predictor-criterion vector in order to produce a second criterion of residual vector. The same method was then repeated or iterated, with the residual criterion vector.

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[1] IBM 709 Correlation Program for SHARE 215.

[2] Richard C. Sorensen and August Dvorak, "An IBM Type 709/7090 Program to Select Predictors, Calculate Multiple Correlations, and Determine Linear Regression Equations," IBM Type 709 Program. Library Report (Seattle: Division of Counseling & Testing Services, n.d.), 10 pp. (Ditto.)

This iteration procedure was continued until the residual vector values for all predictors reached the predetermined limit of .0010. After each iterative cycle, or repetition, the method provided the following: the squared multiple-correlation coefficient (R^2), a result of the cumulative sum of the square of the high values on the predictor-criteria vectors; the corresponding corrected squared multiple correlation coefficients (Rc^2); the corrected multiple correlation coefficient (Rc); the beta coefficient (B's); and the b-weights corresponding to each of the B's.

A spuriously high multiple correlation might have occurred since the iteration technique used in the study selected the highest value in the predictor-criterion vector. The multiple correlation of this predictor-criterion vector is always higher than the initial value of the high multiple correlation. Therefore, a small sample could lead to the spuriously high correlation for some of the other criterion areas.

The predictor b-weights determined from the Horst iteration procedure on the Group 1 1958-1960 Washington State University freshmen were substituted in the present IBM 709 computer program used in the Washington Pre-College Testing Program. New predicted grade-point averages were computed for the 1961 Group 2 Washington State University freshmen in the 36 criterion areas. A comparison was then made of the grade predictions in the 36 criterion areas, by the two different prediction methods, data based on grades

obtained by students at University of Washington and by students at Washington State University. The comparison of the two prediction methods was made on the 1961 Group 2 Washington State University entering freshmen. Thus, for each freshman enrolled, the comparison involved the actual achieved grade-point average, with the predicted grade point based upon normative data at University of Washington and with the predicted grade point based upon normative data at Washington State University.

Summary

The sources of data for this study were the test records and achieved grades for the 1958-1961 entering freshmen at Washington State University. The data were primarily used with computerized procedures and programs, special programs were modified for the grade summarization procedure and the iteration procedure.

The procedure for the study were calculated to develop, by use of the Horst iteration method, a set of multiple predictions using the achieved grades and test data for Washington State University students and comparing these predictions with those of the Washington Pre-College Testing Program.

Chapter IV will present the evaluation and interpretation of this data.

CHAPTER IV

EVALUATION AND INTERPRETATION OF DATA

The purpose of this study was to evaluate for students entering Washington State University the grade predictions from the Washington Pre-College Testing Program. These grade predictions were based upon normative data from students at another university. This chapter is concerned with four questions as pertaining to Washington State University students.

1. As measured by high school grades and testing data on the Washington Pre-College Testing Program are there differences in student aptitudes and achievements between students in a Washington State University normative group and students in the University of Washington's normative group?

2. How accurate are the current predicted grades of the Washington Pre-College Testing Program for students at Washington State University at various levels of student academic progress--freshman, sophomore, or senior level? Can the grade prediction be used to predict grades at all three levels equally well?

3. Is there a hierarchy in the subject matter areas as represented by the predicted and achieved grades from the Washington Pre-College Testing Program and what similarity

does this hierarchy have to the predicted and achieved grades for students at Washington State University?

4. Are the present predictor equations used in the Washington Pre-College Testing Program valid for Washington State University students or should there be developed predictor equations based on the grades achieved by students at Washington State University?

1. As measured by high school grades and testing data on the Washington Pre-College Testing Program are there differences in student aptitudes and achievements between students in a Washington State University normative group and students in the University of Washington's normative group?

At Washington State University there were 2,276 freshmen in the 1958-1960 group--48% women and 52% men. The 1954-1955 University of Washington group was composed of 5,531 students--35.7% women and 64.3% men. The means and standard deviations for high school grades and test scores are shown in Table 3. The 1958-1960 freshmen at Washington State University had higher mean grades in four high school subject areas and more restricted standard deviations in all six subject areas.

The Washington State University normative group tested higher than the University of Washington normative group in English Usage (mean difference of 12.01), spelling (mean difference of 1.56), mathematics (mean difference of 1.73), social studies (mean difference of 0.20), and A.C.E.-Q (mean difference of 3.10). The University of Washington group tested higher on the Guilford-Zimmerman Mechanical Knowledge (mean difference of 2.90) and was higher in age

Table 3. Means and standard deviations of predictor variables for 1958-1960 freshmen at Washington State University and 1954-1955 freshmen at University of Washington.

Predictor Variables	W.S.U. Means	W.S.U. S.D.	U.W. Means	U.W. S.D.	Mean Diff.
1. H. S. English	2.89	.65	2.84	.69	.05
2. H. S. Mathematics	2.68	.74	2.64	.77	.04
3. H. S. Foreign Language	2.70	.80	2.66	.82	.04
4. H. S. Social Science	2.97	.65	2.90	.70	.07
5. H. S. Natural Science	2.80	.69	2.81	.70	.01
6. H. S. Electives	3.11	.55	3.11	.55	.00
7. Guilford-Z Verbal	25.06	10.05	25.88	11.10	-.82
8. Guilford-Z Mech. Kn.	14.22	12.42	17.12	13.42	-3.90
9. English Verbal	99.45	26.03	87.44	28.37	12.01
10. Spelling	17.86	9.70	16.30	9.75	1.56
11. Mathematics	22.13	9.31	20.40	9.32	1.73
12. Social Studies	17.21	6.62	17.01	7.05	.20
13. A.C.E. - Q	47.14	9.43	43.94	10.62	-3.20
14. Age	18.29	.63	18.67	2.03	-.38
15. Sex	.48	.48	.36	.48	.12
16. A.C.E. - L	67.24	13.54	65.29	14.13	1.95
17. Coop. Reading Speed	24.91	9.54	26.13	9.67	-1.22
18. Coop. Reading Level	16.35	5.13	18.41	6.03	-2.06
Total N =	2,276		5,531		

(mean difference of .38 years).

The larger differences in Guilford-Zimmerman Mechanical Knowledge, English Usage, and A.C.E.-Q may be explained by the larger number of men in the University of Washington group.[1] The University of Washington group, with a mean age of 18.67, was older than the Washington State University group whose mean age was 18.29.

An inspection of the high school grades and test scores of the two normative groups showed the two groups were similar and comparable for the purpose of this study; i.e., the purpose of the use of test scores and high school grade averages for comparative use within the counseling and guidance functions. A statistical comparison was not used for the small differences, such differences being irrelevant to any comparative interpretation drawn from test scores and grades and used by the personnel in the guidance setting.

2. How accurate are the current predicted grades of the Washington Pre-College Testing Program for students at Washington State University at various levels of student academic progress--freshman, sophomore, or senior level? Can the grade predictions be used to predict achieved grades at all three levels equally well?

The grade summarization program for the IBM 709 computer summarized three sets of achieved grades--cumulative

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[1]Louise B. Heathers, Robert Kintneo, Thomas D. Langen, and Susan Bjork, "Comparison of Male and Female Students in the 1961 Entering Freshman Class of the University," part of DCT Project 0961-100 (Seattle, Washington: Division of Counseling and Testing Services, University of Washington). (Dittoed.)

freshman (01), cumulative freshman and sophomore (02), and cumulative freshman, sophomore and junior (03) averages for the 1961 Washington State University freshmen.[1] The achieved grades were summarized in grade-point averages and used subsequently as equals, regardless of the calculated credit hours contained in each number. For each student the differences were calculated between the Washington Pre-College Testing Program predicted grade-point average and the achieved grade point at each of the three levels. The derivation of the frequencies, the percentages of the errors of the prediction, and the cumulative percentages were calculated for the 36 criterion areas using Program 0083 for the IBM 1401.[2] The cumulative percentages are presented in Table 4 for each of the three methods of calculation.

The summary of absolute differences, expressed as cumulative percentages between the predicted and the three levels of achieved grades, cumulative freshmen (01), cumulative freshmen and sophomore (02), cumulative freshmen-junior (03), illustrated a similarity between percentages for the 36 criterion areas. Statistically differences at the .05 level were found for some absolute differences for Bacteriology, Home Economics, Political Science, and Zoology. These differences were primarily between the cumulative

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[1] Atkinson, op. cit.

[2] James Thummel, "An IBM 1401 Program to Summarize Differences in Percentages of Grade-Point Averages." Washington State University. (Dittoed.)

Table 4. A comparison of differences between W.P.C.T.P. predicted grade-point averages and achieved grade-point averages for the 1961 freshmen at W.S.U. Differences given in cumulative percentages for three levels of achievement, freshmen (01), freshmen and sophomores (02), and juniors and seniors (03).

	All-University			Accounting		
Absolute Difference	01	02	03	01	02	03
0.0	8.90	9.03	9.24	3.70	3.51	5.13
0.1	25.62	25.39	24.80	7.40	14.06	14.37
0.2	40.72	40.40	39.23	14.80	21.09	22.24
0.3	53.29	53.36	52.92	25.91	28.12	33.19
0.4	63.24	64.05	63.69	29.61	35.65	39.69
0.5	71.18	71.86	72.06	40.72	44.69	49.96
0.6	79.21	78.80	79.43	44.42	51.72	58.52
0.7	84.53	84.73	84.92	70.34	59.25	65.02
0.8	88.85	88.96	89.10	81.45	65.78	71.18
0.9	91.73	91.97	91.89	81.45	70.80	75.97
1.0	93.78	94.54	94.24	85.15	72.32	80.42
1.1	95.83	95.80	95.94	88.85	80.84	83.84
1.2	96.87	97.02	96.94	96.25	83.85	87.26
1.3	97.87	97.84	97.81	96.25	85.35	89.31
1.4	98.43	98.40	98.42	96.25	89.37	90.67
1.5	98.73	98.70	98.76	99.95	90.87	93.06
1.6	99.21	99.18	99.23	99.95	91.87	93.40
1.7	99.25	99.26	99.31	99.95	92.37	93.74
1.8	99.42	99.43	99.48	99.95	92.37	94.42
1.9	99.59	99.60	99.65	99.95	95.38	96.13
2.0	99.63	99.64	99.69	99.95	96.88	96.81
2.1	99.67	99.68	99.73	99.95	97.88	97.83
2.2	99.80	99.81	99.86	99.95	97.88	98.85
2.3	99.84	99.85	99.86	99.95	98.88	98.85
2.4	99.88	99.89	99.90	99.95	99.38	99.53
2.5	99.88	99.89	99.90	99.95	99.88	99.53
2.6	99.88	99.89	99.90	99.95	99.88	99.53
2.7	99.88	99.89	99.90	99.95	99.88	99.87
2.8	99.88	99.89	99.90	99.95	99.88	99.87
2.9	99.88	99.89	99.90	99.95	99.88	99.87
3.0	99.88	99.89	99.90	99.95	99.88	99.87

Table 4. Continued

	Anthropology			Architecture		
Absolute Difference	01	02	03	01	02	03
0.0	5.67	5.92	5.56	0.00	1.42	1.35
0.1	14.27	15.44	16.00	8.33	8.56	6.75
0.2	23.39	24.32	25.51	19.99	18.56	16.20
0.3	29.93	31.65	33.28	26.65	25.70	24.30
0.4	36.64	38.85	40.35	34.98	35.70	33.75
0.5	45.59	47.34	49.63	43.31	44.27	41.85
0.6	52.64	54.67	56.47	48.31	47.12	47.25
0.7	58.66	60.71	62.15	53.31	54.26	52.65
0.8	66.92	68.56	69.69	54.97	59.97	60.75
0.9	72.77	74.09	75.25	56.63	61.39	63.45
1.0	77.76	78.46	80.00	58.29	65.67	67.50
1.1	81.37	82.06	83.48	64.95	75.67	75.60
1.2	85.50	85.53	86.96	69.95	78.52	78.30
1.3	87.90	87.84	89.04	76.61	82.80	82.35
1.4	89.62	89.89	91.01	79.94	84.22	83.70
1.5	92.20	92.20	92.98	81.60	85.64	85.05
1.6	92.71	93.35	94.14	86.60	91.35	90.45
1.7	94.08	94.50	95.06	88.26	91.35	90.45
1.8	95.80	95.91	96.33	89.92	94.20	93.15
1.9	96.83	97.06	97.25	91.58	94.20	93.15
2.0	97.51	98.21	98.17	93.24	95.62	94.50
2.1	97.85	98.33	98.28	93.24	95.62	95.85
2.2	98.36	98.84	98.86	94.90	97.04	97.20
2.3	99.04	99.35	99.32	96.56	98.46	98.55
2.4	99.38	99.60	99.66	98.22	99.88	99.90
2.5	99.72	99.72	99.77	98.22	99.88	99.90
2.6	99.72	99.72	99.77	99.88	99.88	99.90
2.7	99.89	99.84	99.88	99.88	99.88	99.90
2.8	99.89	99.84	99.88	99.88	99.88	99.90
2.9	99.89	99.84	99.88	99.88	99.88	99.90
3.0	99.89	99.84	99.88	99.88	99.88	99.90

Table 4. Continued.

Absolute Difference	Art			Bacteriology		
	01	02	03	01	02	03
0.0	3.39	3.13	3.78	3.40	3.66	5.01
0.1	7.82	10.31	10.19	10.78	12.03	13.62
0.2	14.08	17.49	17.92	19.30	20.93	24.04
0.3	22.95	26.32	26.80	26.11	28.78	31.45
0.4	35.22	37.18	37.49	35.76	40.29	41.47
0.5	48.01	49.88	50.48	40.30	47.09	48.68**
0.6	60.80	62.77	62.98	46.55	55.72	57.69**
0.7	69.93	71.42	71.53	51.66	60.69	62.90**
0.8	75.67	76.94	76.79	57.91	66.44	69.11**
0.9	79.58	81.17	81.06	62.45	70.36	73.51**
1.0	81.92	83.93	84.18	68.13	76.11	79.32**
1.1	83.48	85.40	86.31	72.10	79.51	82.72**
1.2	85.30	87.05	87.95	75.50	83.17	85.92**
1.3	88.17	89.62	90.08	81.18	87.35	89.32
1.4	91.04	92.19	92.71	84.58	89.96	91.52
1.5	92.86	93.66	94.02	85.71	91.79	92.52
1.6	94.68	95.50	95.82	87.41	93.09	93.92
1.7	94.94	95.68	95.98	89.11	94.92	95.32
1.8	95.46	96.23	96.63	91.38	96.75	96.32
1.9	95.46	96.41	96.79	91.94	96.75	96.52
2.0	95.72	96.59	96.95	94.21	97.01	96.72
2.1	95.98	96.77	97.11	97.05	98.58	98.12
2.2	96.50	97.13	97.43	98.18	98.84	98.52
2.3	97.02	97.49	97.75	98.74	99.10	98.92
2.4	97.80	98.22	98.40	98.74	99.10	99.32
2.5	98.58	98.95	99.05	99.30	99.36	99.52
2.6	99.62	99.68	99.70	99.86	99.88	99.92
2.7	99.62	99.68	99.70	99.86	99.88	99.92
2.8	99.62	99.68	99.70	99.86	99.88	99.92
2.9	99.88	99.86	99.86	99.86	99.88	99.92
3.0	99.88	99.86	99.86	99.86	99.88	99.92

**Significant at .05 level.

Table 4. Continued.

Absolute Difference	Biology			Botany		
	01	02	03	01	02	03
0.0	3.78	2.94	2.76	2.27	2.67	2.23
0.1	16.71	14.30	13.62	9.54	10.97	9.69
0.2	24.59	22.08	21.53	14.54	16.60	16.90
0.3	33.73	31.34	31.29	22.26	24.01	24.36
0.4	42.56	39.34	39.57	29.53	31.42	31.82
0.5	53.60	49.86	49.69	37.25	38.54	38.28
0.6	58.64	55.33	55.39	45.43	46.55	44.99
0.7	65.26	62.27	62.20	51.79	53.07	51.20
0.8	71.88	69.00	68.64	57.69	58.70	56.42
0.9	76.92	74.68	74.90	62.69	63.74	61.89
1.0	80.39	79.73	80.42	65.41	67.30	65.62
1.1	86.06	84.15	84.83	70.86	72.64	70.84
1.2	88.89	87.51	88.32	75.40	77.68	75.56
1.3	89.83	88.56	89.60	79.49	82.13	81.03
1.4	91.72	90.45	90.70	82.67	86.58	85.25
1.5	92.66	92.13	92.17	86.30	89.25	88.48
1.6	94.23	93.81	93.45	89.02	91.32	89.97
1.7	95.80	95.91	96.02	92.20	93.99	92.70
1.8	97.06	97.17	97.12	94.47	95.77	95.18
1.9	97.37	97.80	97.67	95.37	96.36	95.67
2.0	98.00	98.64	98.40	95.37	96.36	95.91
2.1	98.63	98.85	98.58	96.27	97.25	97.15
2.2	98.94	99.06	98.94	96.72	97.54	97.39
2.3	99.25	99.48	99.30	98.08	98.13	97.88
2.4	99.25	99.48	99.30	98.08	98.42	98.37
2.5	99.25	99.69	99.48	98.53	98.71	98.61
2.6	99.56	99.90	99.84	98.53	99.00	98.85
2.7	99.56	99.90	99.84	98.98	99.29	99.34
2.8	99.56	99.90	99.84	98.98	99.29	99.34
2.9	99.56	99.90	99.84	99.43	99.58	99.58
3.0	99.87	99.90	99.84	99.88	99.87	99.82

Table 4. Continued.

	Business Administration			Chemistry		
Absolute Difference	01	02	03	01	02	03
0.0	2.88	5.11	6.57	4.22	4.27	4.60
0.1	14.41	13.77	19.72	15.22	15.09	15.54
0.2	28.83	24.39	30.40	23.66	25.21	25.52
0.3	37.48	35.41	40.81	33.32	34.44	34.73
0.4	44.21	45.25	50.67	41.87	43.27	43.46
0.5	49.97	54.69	59.16	51.42	51.81	51.90
0.6	55.73	60.59	64.36	58.42	59.25	60.24
0.7	62.46	66.88	69.56	64.86	65.60	66.47
0.8	70.15	72.78	76.13	71.08	71.35	72.61
0.9	74.95	78.29	80.78	75.19	75.71	76.83
1.0	78.79	83.40	86.53	79.07	80.47	81.05
1.1	78.79	84.97	87.89	81.95	83.64	84.60
1.2	83.59	88.90	91.17	85.28	86.81	87.38
1.3	88.39	91.65	93.08	87.83	89.39	90.16
1.4	88.39	93.61	94.72	90.83	91.87	91.98
1.5	89.35	94.79	96.08	92.38	93.26	93.32
1.6	91.27	96.36	96.90	94.49	95.24	95.23
1.7	92.23	97.54	97.72	95.60	96.33	96.28
1.8	92.23	97.93	97.99	96.26	96.82	96.85
1.9	93.19	98.32	98.26	97.26	97.71	97.71
2.0	93.19	98.32	98.26	98.14	98.40	98.47
2.1	96.07	98.32	98.53	98.80	98.89	98.94
2.2	97.99	99.10	98.80	99.02	98.98	99.03
2.3	98.95	99.49	99.07	99.02	99.07	99.12
2.4	98.95	99.49	99.07	99.46	99.36	99.40
2.5	99.91	99.88	99.34	99.57	99.45	99.49
2.6	99.91	99.88	99.61	99.57	99.45	99.49
2.7	99.91	99.88	99.88	99.68	99.54	99.58
2.8	99.91	99.88	99.88	99.90	99.73	99.77
2.9	99.91	99.88	99.88	99.90	99.73	99.77
3.0	99.91	99.88	99.88	99.90	99.82	99.86

Table 4. Continued.

Absolute Difference	Economics			Drama		
	01	02	03	01	02	03
0.0	6.06	5.21	5.25	2.08	2.94	5.26
0.1	24.24	17.26	17.10	14.58	11.76	13.53
0.2	30.30	30.20	30.44	22.91	24.50	24.80
0.3	33.33	39.73	38.52	27.07	38.22	36.07
0.4	33.33	47.46	47.28	33.32	48.02	44.34
0.5	36.36	53.75	54.69	33.32	53.90	54.86
0.6	39.39	61.66	62.23	47.90	62.72	63.13
0.7	51.51	67.05	67.35	66.65	76.44	75.16
0.8	60.60	72.44	73.95	72.90	82.32	81.17
0.9	66.66	76.75	78.53	74.98	83.30	84.92
1.0	78.78	81.60	82.70	79.14	86.24	86.42
1.1	90.90	85.55	86.87	83.30	88.20	89.42
1.2	90.90	87.16	89.29	95.80	93.10	93.93
1.3	90.90	88.77	91.04	95.80	94.08	95.43
1.4	93.93	92.00	92.92	95.80	96.04	96.18
1.5	93.93	93.61	94.26	95.80	96.04	96.18
1.6	93.93	94.86	95.33	95.80	97.02	96.93
1.7	93.93	95.75	96.27	95.80	98.98	97.68
1.8	93.93	96.46	97.07	95.80	98.98	98.43
1.9	93.93	96.81	97.33	97.88	99.96	99.18
2.0	96.96	97.34	97.73	97.88	99.96	99.18
2.1	96.96	98.59	98.67	97.88	99.96	99.18
2.2	96.96	99.48	99.47	99.96	99.96	99.18
2.3	99.99	99.48	99.60	99.96	99.96	99.18
2.4	99.99	99.48	99.73	99.96	99.96	99.18
2.5	99.99	99.65	99.86	99.96	99.96	99.18
2.6	99.99	99.82	99.86	99.96	99.96	99.18
2.7	99.99	99.82	99.86	99.96	99.96	99.18
2.8	99.99	99.82	99.86	99.96	99.96	99.18
2.9	99.99	99.82	99.86	99.96	99.96	99.18
3.0	99.99	99.82	99.86	99.96	99.96	99.93

Table 4. Continued.

Absolute Difference	Education			Engineering		
	01	02	03	01	02	03
0.0	5.22	5.06	5.10	5.72	4.18	4.44
0.1	16.65	18.98	19.16	14.47	15.17	14.74
0.2	27.10	31.81	31.98	19.52	21.71	21.06
0.3	39.19	43.20	46.19**	25.91	28.77	26.91
0.4	48.01	49.89	54.38	33.99	35.57	35.10
0.5	58.79	60.55	63.96	38.36	41.32	41.18
0.6	72.18	69.22	71.99	45.43	46.29	47.03
0.7	78.06	74.28	76.16	49.80	53.61	52.41
0.8	82.63	78.61	80.17	55.86	59.10	56.85
0.9	87.20	82.04	84.18	62.25	64.85	61.29
1.0	91.77	86.19	87.27	65.95	68.25	65.03
1.1	93.73	89.44	89.89	68.30	72.96	70.18
1.2	94.71	91.97	92.36	71.66	75.05	71.81
1.3	95.69	93.77	94.06	75.02	78.19	74.15
1.4	97.32	95.57	95.91	77.04	80.02	76.49
1.5	97.32	95.75	96.06	80.07	80.80	76.72
1.6	98.30	97.01	97.45	83.10	82.89	78.12
1.7	98.30	97.19	97.60	85.12	83.41	78.58
1.8	98.62	97.91	98.06	88.15	85.24	80.21
1.9	98.94	98.27	98.21	90.84	87.07	82.08
2.0	98.94	98.45	98.36	92.86	88.11	83.25
2.1	98.94	98.63	98.51	93.87	88.37	83.48
2.2	99.26	99.17	99.12	94.54	88.63	83.71
2.3	99.26	99.35	99.27	95.21	89.15	84.17
2.4	99.58	99.53	99.42	95.54	89.41	84.40
2.5	99.58	99.71	99.57	95.54	89.41	84.40
2.6	99.58	99.71	99.57	95.54	89.41	84.40
2.7	99.58	99.71	99.57	95.87	89.67	84.63
2.8	99.90	99.89	99.87	95.87	89.67	84.63
2.9	99.90	99.89	99.87	95.87	89.67	84.63
3.0	99.90	99.89	99.87	99.91	99.87	99.85

**Significant at .05 level.

Table 4. Continued.

Absolute Difference	English Composition			English Literature		
	01	02	03	01	02	03
0.0		3.82	4.85	6.20	7.83	7.84
0.1		15.73	14.31	18.17	18.64	20.58
0.2		28.07	28.12	31.91	33.09	34.80
0.3		38.28	39.11	40.55	42.00	45.49
0.4		43.81	46.01	46.09	49.70	51.51**
0.5		48.91	52.91	55.18	58.34	60.49
0.6		56.99	61.60	63.60	66.31	68.90
0.7		64.64	66.97	70.47	72.93	75.49
0.8		74.85	74.89	78.67	79.55	82.08
0.9		79.10	79.23	82.88	84.14	86.28
1.0		83.35	83.32	86.87	89.14	90.71
1.1		87.17	86.13	91.08	92.11	92.98
1.2		90.99	90.22	93.74	94.13	94.91
1.3		91.84	92.26	95.07	95.48	96.16
1.4		94.39	94.05	95.95	96.15	96.95
1.5		94.81	95.07	97.28	97.09	97.74
1.6		96.08	96.34	97.94	98.30	98.53
1.7		96.50	97.36	97.94	98.70	98.98
1.8		96.50	97.61	98.16	98.70	98.98
1.9		98.20	98.88	98.82	99.24	99.20
2.0		98.20	98.88	99.48	99.51	99.42
2.1		98.20	99.13	99.70	99.78	99.64
2.2		98.62	99.13	99.92	99.91	99.86
2.3		99.04	99.38	99.92	99.91	99.86
2.4		99.46	99.63	99.92	99.91	99.86
2.5		99.46	99.63	99.92	99.91	99.86
2.6		99.46	99.63	99.92	99.91	99.86
2.7		99.88	99.88	99.92	99.91	99.86
2.8		99.88	99.88	99.92	99.91	99.86
2.9		99.88	99.88	99.92	99.91	99.86
3.0		99.88	99.88	99.92	99.91	99.86

**Significant at the .05 level.

Table 4. Continued.

	Languages			Forestry		
Absolute Difference	01	02	03	01	02	03
0.0	4.60	4.85	4.94	6.52	6.77	7.81
0.1	12.54	12.61	12.78	15.21	18.63	17.18
0.2	18.39	20.37	22.37	23.90	27.10	24.99
0.3	28.01	29.75	29.34	32.59	32.18	32.80
0.4	38.05	39.45	38.64	39.11	40.65	42.17
0.5	46.41	47.54	46.48	43.45	50.81	49.98
0.6	52.26	55.63	53.74	43.45	52.50	51.54
0.7	59.37	61.45	49.84	49.97	59.27	57.79
0.8	63.13	65.33	63.61	52.14	62.65	60.91
0.9	68.15	70.83	68.84	58.66	71.12	73.41
1.0	72.75	76.00	73.78	69.52	79.59	81.22
1.1	76.51	79.23	77.55	71.69	82.97	84.34
1.2	78.60	81.17	80.74	73.86	84.66	87.46
1.3	81.11	83.43	83.93	73.86	84.66	87.46
1.4	85.29	86.98	87.12	76.03	86.35	89.02
1.5	87.38	89.24	88.86	78.20	88.04	89.02
1.6	89.47	90.85	90.31	82.54	88.04	89.02
1.7	90.30	91.82	90.89	84.71	91.42	90.58
1.8	91.55	92.79	92.92	89.05	93.11	92.14
1.9	93.22	94.08	94.37	95.57	96.49	96.82
2.0	93.63	94.08	94.95	99.91	98.18	98.38
2.1	96.14	96.66	96.98	99.91	98.18	98.38
2.2	97.39	97.63	97.85	99.91	98.08	98.38
2.3	97.80	97.95	98.14	99.91	98.18	98.38
2.4	98.21	98.27	98.43	99.91	98.18	98.38
2.5	99.04	98.91	99.30	99.91	98.18	98.38
2.6	99.45	98.91	99.30	99.91	98.18	98.38
2.7	99.45	98.91	99.30	99.91	98.18	98.38
2.8	99.45	98.91	99.30	99.91	98.18	98.38
2.9	99.45	98.91	99.30	99.91	98.18	98.38
3.0	99.86	99.88	99.88	99.91	99.87	99.94

Table 4. Continued.

Absolute Difference	Geography			Geology		
	01	02	03	01	02	03
0.0	3.73	4.04	3.67	4.00	5.17	5.09
0.1	17.43	17.19	17.30	11.33	13.03	13.74
0.2	27.08	28.52	29.01	23.33	26.48	27.15
0.3	35.17	37.22	37.05	35.33	36.62	37.16
0.4	44.51	46.73	46.49	43.33	44.90	45.30
0.5	53.54	55.63	55.93	51.33	52.14	52.60
0.6	60.39	62.31	62.22	57.66	58.55	59.05
0.7	68.48	69.39	69.03	63.66	64.55	65.16
0.8	74.71	75.05	74.97	67.66	69.72	70.08
0.9	79.38	79.90	79.69	73.99	75.51	76.19
1.0	83.42	84.55	84.23	80.32	81.10	81.79
1.1	88.09	88.39	88.25	83.98	84.82	85.86
1.2	92.13	91.62	91.39	89.31	89.16	89.76
1.3	94.31	93.84	93.31	91.31	91.85	91.62
1.4	96.17	95.86	95.58	92.31	92.67	92.46
1.5	97.41	96.66	96.80	94.31	94.32	94.49
1.6	98.03	97.46	97.67	94.97	95.14	95.16
1.7	98.34	98.26	98.36	95.97	96.38	96.51
1.8	98.34	98.26	98.36	96.97	97.00	97.01
1.9	98.65	98.66	98.53	97.63	97.62	97.51
2.0	98.96	99.06	99.05	98.29	98.24	98.18
2.1	99.27	99.26	99.22	98.62	98.65	98.68
2.2	99.27	99.46	99.39	99.28	99.27	99.18
2.3	99.58	99.66	99.56	99.28	99.27	99.18
2.4	99.89	99.86	99.73	99.94	99.68	99.68
2.5	99.89	99.86	99.73	99.94	99.68	99.68
2.6	99.89	99.86	99.73	99.94	99.88	99.84
2.7	99.89	99.86	99.73	99.94	99.88	99.84
2.8	99.89	99.86	99.90	99.94	99.88	99.84
2.9	99.89	99.86	99.90	99.94	99.88	99.84
3.0	99.89	99.86	99.90	99.94	99.88	99.84

Table 4. Continued.

Absolute Difference	History			Journalism		
	01	02	03	01	02	03
0.0	5.19	5.30	6.45	6.81	2.77	4.95
0.1	18.54	17.24	18.62	11.35	6.93	11.88
0.2	29.48	29.66	30.58	27.25	19.43	24.75
0.3	40.05	41.84	42.75	31.79	34.70	36.63
0.4	50.43	52.93	51.69	43.15	43.03	45.54
0.5	55.81	59.68	58.87	49.96	48.58	51.48
0.6	62.30	66.43	66.77	59.05	56.91	57.42
0.7	68.23	71.85	72.90	65.86	63.85	64.35
0.8	73.42	76.55	76.64	70.40	73.57	73.26
0.9	76.75	80.41	81.01	72.67	74.95	78.21
1.0	80.64	84.51	84.65	81.76	79.11	81.18
1.1	84.16	87.52	87.66	88.57	84.66	85.14
1.2	86.76	90.29	90.67	88.57	88.82	88.11
1.3	90.27	92.46	92.85	88.57	90.20	91.08
1.4	92.12	94.75	94.82	90.84	90.20	92.07
1.5	94.16	96.07	95.86	90.84	90.20	92.07
1.6	94.53	96.31	96.06	95.38	92.97	94.05
1.7	96.75	97.39	97.10	95.38	94.35	95.04
1.8	97.30	97.75	97.62	97.65	95.73	96.03
1.9	97.85	97.99	97.82	97.65	95.73	97.02
2.0	98.22	98.35	98.44	99.92	97.11	98.01
2.1	98.40	98.71	98.96	99.92	97.11	98.01
2.2	98.95	99.07	99.06	99.92	97.11	98.01
2.3	99.32	99.31	99.26	99.92	97.11	98.01
2.4	99.50	99.79	99.67	99.92	97.11	98.01
2.5	99.50	99.79	99.67	99.92	97.11	98.01
2.6	99.87	99.91	99.77	99.92	97.11	98.01
2.7	99.87	99.91	99.77	99.92	97.11	98.01
2.8	99.87	99.91	99.87	99.92	98.49	99.00
2.9	99.87	99.91	99.87	99.92	98.49	99.00
3.0	99.87	99.91	99.87	99.92	99.87	99.99

Table 4. Continued.

Absolute Difference	Home Economics			Mathematics		
	01	02	03	01	02	03
0.0	2.94	5.78	5.62	3.78	4.35	3.77
0.1	11.76	14.28	14.99	12.92	13.13	12.83
0.2	20.58	23.46	23.42	22.15	22.77	22.54
0.3	31.98	35.36	38.42	30.73	31.89	32.33
0.4	40.74	43.18	48.42**	39.50	41.01	41.47
0.5	51.24	51.34	55.29	45.77	47.75	48.05
0.6	57.12	57.80	61.22	52.51	55.08	55.11
0.7	65.10	65.96	68.09	58.14	60.79	61.45
0.8	70.56	71.06	71.52	64.23	66.59	67.30
0.9	76.02	76.84	76.83	69.67	71.96	72.51
1.0	79.80	79.22	79.01	73.73	75.28	76.20
1.1	82.74	82.62	82.44	77.70	79.03	79.73
1.2	84.42	85.00	84.31	82.22	83.46	83.58
1.3	87.78	87.38	86.49	85.63	87.04	87.43
1.4	89.88	90.10	88.99	88.67	89.77	89.99
1.5	91.56	91.80	90.86	90.97	91.73	91.83
1.6	92.40	92.48	91.48	92.81	93.60	93.67
1.7	94.50	94.18	93.04	94.84	95.13	95.19
1.8	95.76	95.20	94.29	96.13	96.40	96.71
1.9	96.18	95.54	94.60	97.42	97.76	97.99
2.0	97.02	96.22	95.22	98.52	98.61	98.87
2.1	97.02	96.22	95.22	98.79	97.78	98.95
2.2	97.02	96.22	95.22	99.06	99.12	99.19
2.3	98.28	97.24	96.15	99.24	99.37	99.43
2.4	98.28	97.24	96.15	99.33	99.45	99.51
2.5	98.28	97.24	96.15	99.42	99.53	99.59
2.6	98.70	97.58	96.46	99.42	99.53	99.59
2.7	98.70	97.58	96.46	99.60	99.70	99.75
2.8	98.70	97.58	96.46	99.87	99.87	99.91
2.9	98.70	97.58	96.46	99.87	99.87	99.91
3.0	99.96	99.96	99.89	99.87	99.87	99.91

**Significant at the .05 level.

Table 4. Continued.

	Music			Nutrition		
Absolute Difference	01	02	03	01	02	03
0.0	4.49	3.85	5.72	3.50	2.58	3.65
0.1	18.81	18.06	19.70	11.39	11.61	11.57
0.2	30.04	28.18	29.65	15.77	16.77	17.05
0.3	39.30	36.13	36.85	24.54	25.15	25.58
0.4	44.07	39.74	41.72	29.80	34.18	35.33
0.5	48.56	43.59	46.38	33.30	37.40	39.59
0.6	53.61	47.44	49.76	42.07	48.36	52.39
0.7	57.54	52.98	54.63	45.57	54.16	57.87
0.8	60.91	58.28	60.56	49.95	57.38	61.52
0.9	66.80	52.02	68.18	52.58	60.60	65.17
1.0	75.78	73.93	76.44	56.08	65.11	68.82
1.1	84.76	83.56	84.91	63.97	71.56	73.69
1.2	90.09	88.13	89.78	66.60	74.14	76.12
1.3	94.02	92.46	93.59	68.35	76.07	77.94
1.4	94.30	93.90	94.86	70.10	77.36	78.54
1.5	95.42	95.10	96.13	75.36	79.29	79.75
1.6	96.54	96.06	96.55	76.23	79.93	80.35
1.7	96.82	96.30	96.76	76.23	79.93	80.35
1.8	97.66	97.02	97.60	76.23	79.93	80.35
1.9	97.94	97.50	98.02	76.23	79.93	80.35
2.0	98.50	98.22	98.44	76.23	79.93	80.35
2.1	98.78	98.70	98.86	76.23	79.93	80.35
2.2	98.78	98.70	98.86	77.10	80.57	80.95
2.3	98.78	98.70	98.86	77.10	80.57	80.95
2.4	99.06	98.94	99.07	77.10	80.57	80.95
2.5	99.06	98.94	99.07	77.10	80.57	80.95
2.6	99.06	99.18	99.28	77.10	80.57	80.95
2.7	99.06	99.18	99.28	77.10	80.57	80.95
2.8	99.06	99.18	99.28	77.10	80.57	80.95
2.9	99.06	99.18	99.28	77.10	80.57	80.95
3.0	99.90	99.90	99.91	99.90	99.92	99.85

Table 4. Continued.

Absolute Difference	Nursing			Pharmacy		
	01	02	03	01	02	03
0.0	7.31	6.00	6.89	.00	4.00	10.00
0.1	14.62	12.00	15.51		8.00	16.66
0.2	24.37	22.00	24.13		12.00	29.99
0.3	36.56	34.00	36.19		20.00	46.65
0.4	51.19	46.00	48.25		28.00	53.31
0.5	60.94	54.00	55.14		32.00	56.64
0.6	60.94	64.00	58.58		32.00	59.97
0.7	68.25	70.00	65.47		36.00	66.63
0.8	73.12	80.00	70.64		44.00	73.29
0.9	77.99	86.00	79.26		56.00	76.62
1.0	82.86	88.00	84.43		60.00	79.95
1.1	85.29	92.00	89.60		76.00	83.28
1.2	90.16	96.00	93.04		80.00	83.28
1.3	95.03	98.00	96.48		80.00	83.28
1.4	97.46	98.00	98.20		84.00	83.28
1.5	97.46	98.00	98.20		88.00	83.28
1.6	97.46	98.00	98.20		92.00	89.94
1.7	97.46	98.00	98.20		96.00	89.94
1.8	97.46	98.00	98.20		96.00	89.94
1.9	97.46	98.00	98.20		96.00	96.60
2.0	97.46	98.00	98.20		100.00	96.60
2.1	97.46	98.00	98.20		100.00	96.60
2.2	97.46	98.00	98.20		100.00	96.60
2.3	97.46	98.00	98.20		100.00	96.60
2.4	97.46	98.00	98.20		100.00	96.60
2.5	97.46	98.00	98.20		100.00	99.93
2.6	97.46	98.00	98.20		100.00	99.93
2.7	97.46	98.00	98.20		100.00	99.93
2.8	99.89	100.00	99.92		100.00	99.93
2.9	99.89	100.00	99.92		100.00	99.93
3.0	99.89	100.00	99.92		100.00	99.93

Table 4. Continued.

Absolute Difference	Philosophy			Physics		
	01	02	03	01	02	03
0.0	4.74	4.58	4.58		2.94	4.29
0.1	11.51	13.09	14.12		12.74	15.01
0.2	18.62	22.47	23.84		21.07	23.59
0.3	24.38	30.33	31.54		34.30	34.31
0.4	29.12	38.19	39.42		41.16	42.89
0.5	35.56	44.74	46.02		50.47	52.76
0.6	41.32	52.81	52.62		58.31	60.05
0.7	46.40	57.39	57.02		63.70	65.62
0.8	53.51	63.94	64.72		67.62	67.76
0.9	59.61	68.96	69.67		70.56	72.05
1.0	64.35	73.10	73.89		75.46	77.20
1.1	69.09	77.03	78.66		78.89	79.77
1.2	73.15	80.30	81.77		80.36	84.06
1.3	75.86	83.35	84.52		82.32	86.20
1.4	79.24	85.53	86.53		84.77	88.77
1.5	83.64	88.58	89.46		86.24	90.05
1.6	84.99	89.67	90.92		89.18	92.62
1.7	87.02	91.19	92.75		90.16	92.62
1.8	88.37	92.06	93.48		90.16	93.04
1.9	90.74	93.58	94.76		91.63	94.32
2.0	92.77	95.10	96.04		93.10	95.17
2.1	94.46	96.84	97.32		96.53	97.74
2.2	95.81	97.71	97.87		97.02	98.16
2.3	96.48	97.92	98.23		98.49	99.01
2.4	97.49	98.57	98.78		98.98	99.01
2.5	98.50	99.22	99.33		98.98	99.01
2.6	98.83	99.43	99.51		99.47	99.43
2.7	99.50	99.86	99.87		99.96	99.85
2.8	99.83	99.86	99.87		99.96	99.85
2.9	99.83	99.86	99.87		99.96	99.85
3.0	99.83	99.86	99.87		99.96	99.85

Table 4. Continued.

	Political Science			Psychology		
Absolute Difference	01	02	03	01	02	03
0.0	3.61	4.63	5.74	3.27	4.17	4.15
0.1	12.49	14.47	16.29	12.42	13.78	13.91
0.2	21.37	25.47	27.78	21.01	22.62	22.81
0.3	28.93	32.99	36.32	29.14	31.46	31.71
0.4	37.48	41.29	44.54	39.51	41.00	41.14
0.5	44.05	50.74	51.52	48.10	48.86	49.18
0.6	48.98	57.49**	58.19**	55.67	56.79	56.76
0.7	54.90	63.08**	64.40**	61.65	63.26	63.29
0.8	58.84	67.32**	69.36**	68.09	69.66	69.55
0.9	64.43	72.72**	74.32**	78.79	74.60	74.49
1.0	69.03	77.93**	78.97**	77.90	78.36	78.11
1.1	72.97	81.01**	82.54**	82.29	82.60	82.66
1.2	77.24	83.90	85.17**	86.58	86.56	86.81
1.3	80.52	86.21	87.65**	89.66	89.62	90.10
1.4	82.49	87.56	89.04**	92.08	92.26	92.60
1.5	85.77	89.87	91.36	93.29	93.65	93.72
1.6	87.41	91.02	92.75	95.62	95.46	95.43
1.7	89.38	92.56	93.99	96.64	96.78	96.61
1.8	91.35	93.91	95.07	97.66	97.68	97.59
1.9	92.99	95.26	96.31	98.78	98.58	98.51
2.0	94.96	96.61	97.39	99.15	98.99	98.77
2.1	96.27	97.38	98.16	99.43	99.47	99.16
2.2	96.92	97.95	98.47	99.71	99.67	99.48
2.3	97.90	98.52	98.93	99.89	99.67	99.61
2.4	98.55	98.90	99.24	99.89	99.73	99.67
2.5	98.55	98.90	99.24	99.89	99.86	99.86
2.6	98.87	99.28	99.39	99.89	99.86	99.86
2.7	99.85	99.85	99.85	99.89	99.86	99.86
2.8	99.85	99.85	99.85	99.89	99.86	99.86
2.9	99.85	99.85	99.85	99.89	99.86	99.86
3.0	99.85	99.85	99.85	99.89	99.86	99.86

**Significant at the .05 level.

Table 4. Continued.

Absolute Difference	Radio-TV			Sociology		
	01	02	03	01	02	03
0.0	5.88	7.40	3.38	5.35	5.39	5.71
0.1	17.64	18.51	11.85	16.80	17.42	17.58
0.2	23.52	27.76	22.01	28.34	29.52	29.58
0.3	26.46	37.01	33.87	38.89	40.99	40.87
0.4	38.22	48.12	44.03	46.80	49.35	50.21
0.5	49.98	57.37	57.58	56.44	58.96	59.42
0.6	55.86	59.22	59.27	64.93	66.49	66.88
0.7	70.56	70.33	71.13	70.12	71.88	72.20
0.8	73.50	77.73	77.90	75.23	76.65	76.67
0.9	82.32	81.43	82.98	79.26	80.31	80.43
1.0	85.26	83.28	84.67	83.38	84.94	85.03
1.1	85.26	83.28	84.67	86.84	87.77	87.82
1.2	85.26	86.98	88.05	89.23	90.53	90.80
1.3	85.26	90.68	89.74	91.20	92.60	92.87
1.4	91.14	96.23	94.82	92.60	94.12	94.55
1.5	97.02	99.93	98.20	93.91	95.22	95.65
1.6	97.02	99.93	98.20	95.39	96.46	96.81
1.7	97.02	99.93	98.20	96.79	97.63	97.78
1.8	97.02	99.93	98.20	97.20	97.97	98.16
1.9	97.02	99.93	98.20	98.10	98.66	98.74
2.0	97.02	99.93	98.20	98.84	99.14	99.19
2.1	97.02	99.93	98.20	99.25	99.41	99.51
2.2	99.96	99.93	98.20	99.33	99.41	99.51
2.3	99.96	99.93	98.20	99.41	99.47	99.57
2.4	99.96	99.93	98.20	99.65	99.67	99.76
2.5	99.96	99.93	98.20	99.73	99.73	99.82
2.6	99.96	99.93	98.20	99.81	99.79	99.82
2.7	99.96	99.93	98.20	99.81	99.79	99.82
2.8	99.96	99.93	98.20	99.81	99.79	99.82
2.9	99.96	99.93	98.20	99.89	99.85	99.88
3.0	99.96	99.93	99.89	99.89	99.85	99.88

Table 4. Continued.

Absolute Difference	Speech 01	Speech 02	Speech 03	Zoology 01	Zoology 02	Zoology 03
0.0	6.22	5.86	5.47	3.28	4.56	4.53
0.1	20.38	20.17	20.38	9.84	12.32	13.34
0.2	31.32	31.89	33.01	16.40	20.69	22.28
0.3	42.47	42.75	43.81	24.71	29.82	30.29
0.4	52.34	52.57	54.00	32.80	39.10	39.50**
0.5	61.13	60.84	61.15	42.20	46.40	46.84
0.6	67.99	68.25	67.69	48.54	53.24	53.78
0.7	73.99	75.14	73.47	53.79	59.17	58.71
0.8	80.64	81.00	79.86	60.79	64.95	64.58
0.9	84.93	85.82	84.57	65.60	69.51	69.92
1.0	89.22	89.78	89.13	70.85	75.44	75.66
1.1	91.58	92.53	91.41	75.22	79.09	78.86
1.2	94.15	94.59	93.69	79.59	83.04	84.06
1.3	96.08	96.48	95.66	83.52	85.62	86.59
1.4	96.72	97.34	96.42	87.67	89.88	90.19
1.5	96.93	97.51	97.02	91.17	93.07	93.66
1.6	97.57	98.02	97.78	92.92	94.89	95.92
1.7	98.42	98.70	98.23	94.67	95.95	96.85
1.8	98.42	98.87	98.38	96.63	97.31	97.78
1.9	98.63	98.87	98.38	97.06	97.61	97.91
2.0	98.84	99.04	98.68	97.27	97.91	98.17
2.1	98.84	99.04	98.68	98.14	98.67	98.70
2.2	98.84	99.04	98.83	99.01	99.27	99.23
2.3	99.69	99.72	99.59	99.01	99.27	99.23
2.4	99.90	99.89	99.74	99.44	99.57	99.63
2.5	99.90	99.89	99.74	99.65	99.72	99.76
2.6	99.90	99.89	99.74	99.86	99.87	99.89
2.7	99.90	99.89	99.74	99.86	99.87	99.89
2.8	99.90	99.89	99.74	99.86	99.87	99.89
2.9	99.90	99.89	99.89	99.86	99.87	99.89
3.0	99.90	99.89	99.89	99.86	99.87	99.89

**Significant at the .05 level.

freshmen and cumulative freshmen-junior levels.[1]

The correlations and their Z-transformations between the Washington Pre-College Testing Program predicted grades and the three levels of Washington State University student achieved grades are given in Table 5. There were no statistically significant differences between the three levels of achieved grades when correlated with the predicted grades from the Washington Pre-College Testing Program except All-University at the cumulative freshmen and the cumulative freshmen-junior levels, Art at the cumulative freshmen and cumulative freshmen and sophomore levels and the cumulative freshmen and cumulative freshmen-junior levels, English Composition at the cumulative freshmen and sophomore and cumulative freshmen-junior levels, and Bacteriology at the cumulative freshmen and cumulative freshmen and sophomore levels and the cumulative freshmen and cumulative freshmen-junior levels.

The prediction most often used for student assessment, the All-University prediction, indicated very similar absolute differences at the three levels of achievement. Only a slight difference in percentages--79.21 - 78.80 - 79.43--was recorded for the three levels of achievement at the .6 grade-point level of absolute difference. The correlation of the predicted grade with the cumulative freshman level of achieved grade was significantly higher than with

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[1]Appendix B.

Table 5. Correlations, Z-transformations of correlations, means, standard deviations, between W.P.C.T.P. predicted and W.S.U. achieved grade-point averages at the cumulative freshmen level for 1961 W.S.U. freshmen.

Criterion Area	N	r	Z-Values	Mean Ach.	Mean Pred.	S.D. Ach.	S.D. Pred.
All-University	2,274	.6682	.807**	2.16	2.26	.688	.454
Accounting	27	.2372	.242	2.41	2.50	.740	.332
Anthropology	544	.5866	.672	2.14	2.49	.825	.431
Architecture	55	.0910	.091	2.68	2.49	.889	.242
Art	367	.4317	.461*	2.23	2.59	.707	.197
Bacteriology	150	.5030	.555**	1.88	2.22	.802	.377
Biology	277	.6193	.723	2.11	2.02	.860	.703
Botany	189	.4780	.520	2.04	2.14	.920	.780
Business Admin.	98	.3813	.400	2.24	1.97	.854	.414
Chemistry	819	.5634	.637	2.18	2.14	.863	.521
Economics	32	.6790	.827	2.61	2.80	1.000	.370
Drama	48	.3523	.368	2.72	2.71	.868	.454
Education	302	.5188	.575	2.38	2.57	.680	.301
Engineering	261	.4532	.490	2.51	2.22	.914	.235
English Composition							
English Literature	445	.4460	.470	2.47	2.33	.728	.359
Forestry	41	.1950	.196	2.31	2.20	.927	.260
Geography	312	.4620	.501	2.14	2.07	.769	.395
Geology	288	.4127	.438	2.09	2.27	.778	.338
History	513	.4708	.511	2.19	2.31	.769	.342
Journalism	44	.3055	.316	2.79	2.89	.853	.311
Home Economics	230	.4790	.522	2.30	2.68	.769	.301
Languages	217	.4746	.517	2.56	2.72	.893	.510
Mathematics	1,018	.4426	.476	2.23	2.17	.891	.565
Music	352	.0693	.069	3.07	2.98	.780	.189
Nursing	40	.6634	.801	2.67	2.68	.839	.277
Nutrition	87	.4840	.530	2.85	2.64	.897	.492
Pharmacy							
Philosophy	261	.4840	.530	1.99	2.44	.881	.401
Physics							
Political Science	271	.4748	.516	2.11	2.41	.869	.454
Psychology	1,033	.5802	.663	2.37	2.11	.922	.543
Radio & TV	34	.3605	.378	3.11	2.72	.731	.428
Sociology	1,165	.6066	.694	2.21	2.31	.860	.524
Speech	460	.5094	.652	2.50	2.47	.732	.403
Zoology	416	.4942	.538	2.19	2.15	.943	.459

*Significant at the .01 level.

**Significant at the .05 level.

Table 5. Continued. Correlations, Z-transformations of correlations, means, standard deviations, between W.P.C.T.P. predicted and W.S.U. achieved grade-point averages at the cumulative freshmen and sophomore level for 1961 W.S.U. freshmen.

Criterion Area	N	r	Z-Values	Mean Ach.	Mean Pred.	S.D. Ach.	S.D. Pred.
All-University	2,275	.6625	.795	2.14	2.26	.676	.454
Accounting	184	.4271	.456	2.06	2.33	.798	.386
Anthropology	736	.5806	.671	2.21	2.51	.856	.449
Architecture	66	.0708	.071	2.69	2.43	.813	.250
Art	525	.3294	.343*	2.31	2.60	.698	.205
Bacteriology	358	.4562	.492**	2.12	2.27	.859	.388
Biology	436	.5395	.604	2.16	2.09	.889	.729
Botany	307	.4643	.504	2.19	2.22	.942	.733
Business Admin.	248	.3459	.361	2.22	2.20	.768	.450
Chemistry	926	.5381	.601	2.13	2.11	.832	.531
Economics	534	.4964	.545	2.29	2.29	.825	.392
Drama	102	.2613	.268	2.81	2.70	.663	.438
Education	544	.4922	.539	2.41	2.55	.737	.312
Engineering	326	.4125	.438	2.35	2.22	.847	.232
English Composition	231	.6316	.742*	2.69	2.42	.718	.419
English Literature	734	.4209	.448	2.48	2.33	.696	.358
Forestry	54	.2405	.245	2.35	2.20	.755	.252
Geography	482	.5197	.576	2.29	2.11	.780	.410
Geology	469	.3698	.388	2.16	2.27	.777	.343
History	801	.5194	.576	2.23	2.36	.759	.372
Journalism	70	.2279	.232	2.73	2.84	.783	.305
Home Economics	282	.4888	.534	2.33	2.68	.762	.306
Languages	286	.4973	.540	2.49	2.73	.863	.512
Mathematics	111	.4561	.492	2.20	2.17	.884	.558
Music	410	.0194	.019	3.10	2.97	.800	.192
Nursing	49	.6021	.693	2.70	2.70	.829	.277
Nutrition	124	.5126	.554	2.67	2.66	.851	.488
Pharmacy	25	.5099	.550	3.12	2.61	.600	.282
Philosophy	423	.4593	.495	2.11	2.44	.830	.393
Physics	182	.3648	.386	2.30	2.29	.776	.289
Political Science	480	.5126	.567	2.09	2.39	.792	.449
Psychology	1,389	.5529	.622	2.37	2.13	.900	.542
Radio & TV	54	.3806	.406	3.01	2.71	.700	.389
Sociology	1,400	.6010	.690	2.24	2.33	.827	.530
Speech	574	.4697	.510	2.51	2.49	.701	.393
Zoology	609	.4885	.533	2.17	2.15	.892	.465

*Significant at the .01 level.

**Significant at the .05 level.

Table 5. Continued. Correlations, Z-transformations of correlations, means, standard deviations, between W.P.C.T.P. predicted and W.S.U. achieved grade-point averages at the cumulative freshman--junior level for 1961 W.S.U. freshmen.

Criterion Area	N	r	Z-Values	Mean Ach.	Mean Pred.	S.D. Ach.	S.D. Pred.
All-University	2,293	.6549	.744**	2.16	2.26	.678	.454
Accounting	292	.4521	.488	2.00	2.32	.709	.394
Anthropology	862	.5856	.672	2.23	2.50	.851	.452
Architecture	74	.3663	.382	2.72	2.35	.801	.395
Art	608	.3560	.272	2.34	2.60	.713	.207
Bacteriology	499	.4590	.496	2.15	2.27	.824	.413
Biology	543	.5644	.639	2.19	2.09	.903	.735
Botany	402	.4335	.464	2.23	2.21	.970	.730
Business Admin.	365	.4128	.440	2.20	2.25	.714	.455
Chemistry	1,042	.5309	.591	2.12	2.10	.817	.535
Economics	742	.4920	.539	2.24	2.28	.804	.388
Drama	133	.3197	.331	2.83	2.66	.632	.484
Education	647	.5058	.550	2.48	2.53	.727	.312
Engineering	427	.3780	.397	2.34	2.22	.819	.235
English Composition	391	.3929	.420*	2.68	2.39	.707	.449
English Literature	879	.4556	.491	2.49	2.33	.676	.364
Forestry	64	.2178	.221	2.38	2.19	.734	.264
Geography	572	.5096	.563	2.31	2.11	.765	.418
Geology	589	.3897	.410	2.17	2.27	.775	.350
History	961	.5089	.561	2.23	2.33	.746	.347
Journalism	101	.2373	.241	2.75	2.83	.777	.302
Home Economics	320	.4920	.539	2.37	2.69	.760	.307
Languages	344	.5090	.550	2.37	2.69	.864	.526
Mathematics	1,246	.4599	.497	2.21	2.17	.883	.554
Music	472	.0524	.052	3.14	2.97	.771	.188
Nursing	58	.5891	.671	2.78	2.71	.809	.272
Nutrition	164	.5279	.586	2.66	2.65	.809	.471
Pharmacy	30	-.1607	.161	2.78	2.26	.638	.338
Philosophy	545	.4489	.483	2.17	2.43	.849	.392
Physics	233	.3431	.357	2.28	2.27	.773	.292
Political Science	644	.4968	.545	2.08	2.38	.764	.448
Psychology	1,516	.5418	.605	2.37	2.14	.893	.940
Radio & TV	59	.4537	.490	3.01	2.69	.698	.404
Sociology	1,541	.5953	.688	2.26	2.35	.818	.532
Speech	657	.4623	.501	2.53	2.48	.719	.396
Zoology	749	.4674	.507	2.14	2.13	.880	.467

*Significant at the .01 level.

**Significant at the .05 level.

Table 5. Continued. Significance of differences (expressed as t values) of correlations between W.P.C.T.P. predicted and W.S.U. achieved grade-point averages at three levels for 1961 freshmen at Washington State University.

	01-Freshmen 02-Sophomores	01-Freshmen 03-Seniors	02-Sophomores 03-Seniors
All-University	.40	2.17**	1.70
Accounting	.87	.35	1.17
Anthropology	.01	.01	.01
Architecture	.11	1.55	1.71
Art	6.40*	2.82*	1.22
Bacteriology	2.00**	1.99**	.01
Biology	1.58	1.12	.51
Botany	.55	.68	.52
Business Admin.	.10	.10	.96
Chemistry	.75	.99	.21
Economics	1.48	1.52	.10
Drama	.55	.21	.12
Education	.50	.35	.02
Engineering	.63	1.15	.53
English Composition		.01	3.98*
English Literature	.40	.38	.82
Forestry	.23	.12	.13
Geography	1.05	.89	.19
Geology	.67	.39	.32
History	1.20	.94	.33
Journalism	.44	.42	.50
Home Economics	.13	.19	.06
Languages	.25	.36	.01
Mathematics	.34	.48	.01
Music	.70	.24	.48
Nursing	.49	.60	.12
Nutrition	.22	.52	.31
Pharmacy		.01	1.44
Philosophy	.46	.68	.01
Physics		.01	.29
Political Science	.70	.41	.36
Psychology	1.00	1.41	.45
Radio & TV	.12	.50	.56
Sociology	.01	.01	.01
Speech	.83	1.01	.16
Zoology	.01	.57	.50

*Significant at the .01 level.

**Significant at the .05 level.

the cumulative freshman-junior level of achieved grade ($p < .05$).

Accounting cannot be considered a freshman course because the majority of students taking the course are beyond their freshman year. The small number of students concerned invalidates the use of the prediction at the freshman level. The predicted grade had a higher correlation at the cumulative freshman-junior level than the cumulative freshman and sophomore level, although the difference is not statistically significant.

The correlation for Architecture at the cumulative freshman and cumulative freshman and sophomore levels is so low that the use of the predicted grade has little meaning for predicted purposes. At the cumulative freshman-junior level the correlation is .39, a substantial increase over the correlation at the cumulative freshman and cumulative freshman and sophomore levels, but there is little increase in the number of students. Apparently for the same students the achieved grades received at the junior or senior level correlate better with the predicted grades than do the achieved grades at the cumulative freshman and cumulative freshman and sophomore levels.

Art showed a significantly higher correlation at the cumulative freshman level than at either the cumulative freshman and sophomore or cumulative freshman-junior levels ($p < .01$). The freshman grade in art may be more predictable than the grades in later art courses which depend more on

skills not measured by the predictors in the Washington Pre-College Testing Program. The absolute differences between the predicted and the three levels of achieved grades in Table 4 for art reflect a similarity in percentages between the three levels of achieved grades.

Though the differences are not statistically significant, Biology, Botany, Chemistry, Engineering, Geology, Nursing, Philosophy, Psychology, Speech and Zoology showed higher correlations at the cumulative freshman level than the cumulative freshman and sophomore or cumulative freshman-junior levels. In Table 4 for these criterion areas, the cumulative percentages of absolute differences varies among the three levels of achieved grades, a higher cumulative percentage appearing more often at the cumulative freshman-junior level than at the cumulative freshman or cumulative freshman and sophomore levels.

For Business Administration, Geography, History, Languages, Nutrition and Radio and TV, the correlation between predicted and achieved grades showed a trend toward being higher at the cumulative freshman-junior level than the cumulative freshman level. The trend was possibly a result of the restriction of the number of students in the summarization at the freshman or cumulative freshman level for Radio and TV only. Economics and Drama showed a higher correlation at the cumulative freshman level but again the number of students at that level is small, influencing the magnitude of the correlation.

In Table 5 for Anthropology, Education, English Literature, Forestry, Home Economics, Mathematics, Physics, Political Science and Sociology the correlations of the predicted grades with the three levels of achieved grades showed little variation from one level to another.

Bacteriology had a significantly higher correlation at the cumulative freshman level than at the cumulative freshman and sophomore level or cumulative freshman-junior levels ($p < .05$). The large lecture class provided grading patterns more consistent with the predicted grades than did the smaller laboratory orientated classes at the cumulative freshman-junior levels. English Composition had a significantly higher correlation at the cumulative freshman and sophomore level than at the cumulative freshman-junior level ($p < .05$). No freshmen students take course work in this area. Music showed a higher correlation at the cumulative freshman than the cumulative freshman and sophomore or cumulative freshmen-junior levels but the correlation at any level is low, precluding its use for any comparative purpose. Pharmacy, with no students taking course work at the freshman level, showed a higher correlation at the cumulative freshman and sophomore than the cumulative freshman-junior level, the latter correlation being the only negative value registered in this study. The addition of grades during the junior and senior year did not correlate with the grade predictions as did the grades received at the cumulative freshman and sophomore

level. For the four criterion areas discussed in this paragraph the reduction in correlation between the achieved grades and predicted grades may be a function of the restricted grades received by students during the junior and senior years.

The currently used predicted grades of the Washington Pre-College correlated equally well with achieved grades summarized at three levels, cumulative freshman, cumulative freshman and sophomore, cumulative freshman-junior except for the areas of All-University, Art, Bacteriology and English Composition. The latter four correlated higher with achieved grades at the cumulative freshman level.

3. Is there a hierarchy in the subject matter areas as represented by predicted and achieved grades from the Washington Pre-College Testing Program and what similarity does the hierarchy have with the predicted and achieved grades for students at Washington State University?

Two student classes, the 1961 Washington State University freshmen and the University of Washington freshmen of 1955-1956, were used to determine whether (1) the Washington Pre-College Testing Program grade predictions for the two groups were similar in their ranking, (2) whether the ranking of the achieved grades was similar, and (3) for Washington State University, whether the ranking of achieved with predicted grades was similar. A SHARE 966 Program for the IBM 709 computer was used to develop means and standard deviations for the predicted and achieved grades for the 1961 Washington State University freshmen, as given in Table 6. Data for the University of Washington group were

Table 6. Comparison of zero-order correlation coefficients, means, and standard deviations between W.P.C.T.P. predicted and achieved grades for the University of Washington entering freshmen 1955-1956, and Washington State University entering freshmen 1961.

Course	Area	N		r		Mean			Standard Deviations		
		WSU	UW	WSU	UW		WSU	UW		WSU	UW
All-University	1	2293	5517	.66	.64	Predicted	2.27	2.28	Predicted	.47	.46
						Achieved	2.16	2.21	Achieved	.68	.75
Accounting	2	292	1029	.45	.49	Predicted	2.32	2.31	Predicted	.40	.42
						Achieved	2.00	2.11	Achieved	.71	.96
Anthropology	3	862	2282	.59	.51	Predicted	2.50	2.44	Predicted	.45	.45
						Achieved	2.33	2.24	Achieved	.85	.91
Architecture	4	74	124	.36	.26	Predicted	2.35	2.33	Predicted	.26	.29
						Achieved	2.72	2.44	Achieved	.71	.63
Art	5	608	1165	.36	.26	Predicted	2.60	2.65	Predicted	.18	.20
						Achieved	2.34	2.55	Achieved	.77	.67
Bacteriology	6	499	279	.46	.38	Predicted	2.27	2.30	Predicted	.41	.40
						Achieved	2.15	2.47	Achieved	.82	.94
Biology	7	543	222	.56	.66	Predicted	2.09	2.17	Predicted	.74	.76
						Achieved	2.19	2.14	Achieved	.90	1.09
Botany	8	402	373	.43	.58	Predicted	2.21	2.02	Predicted	.73	.71
						Achieved	2.23	1.93	Achieved	.97	1.08
Bus. Admin.	9	365	2262	.41	.53	Predicted	2.25	2.33	Predicted	.45	.48
						Achieved	2.20	2.33	Achieved	.72	.90

Chemistry	10	1042	2509	.53	.57	Predicted	2.10	2.09	Predicted	.54	.53
						Achieved	2.12	2.00	Achieved	.82	.97
Economics	11	742	2301	.49	.47	Predicted	2.28	2.67	Predicted	.38	.40
						Achieved	2.24	2.14	Achieved	.80	.92
Drama	12	133	4864	.32	.43	Predicted	2.66	2.73	Predicted	.48	.53
						Achieved	2.83	2.81	Achieved	.65	.99
Education	13	647	508	.51	.40	Predicted	2.53	2.68	Predicted	.32	.28
						Achieved	2.48	2.57	Achieved	.73	.66
Engineering	14	427	1235	.38	.42	Predicted	2.22	2.31	Predicted	.23	.24
						Achieved	2.35	2.33	Achieved	.81	.75
Eng. Comp.	15	391	4489	.39	.64	Predicted	2.39	2.33	Predicted	.45	.46
						Achieved	2.68	2.19	Achieved	.70	.80
English Lit.	16	879	1585	.46	.51	Predicted	2.33	2.40	Predicted	.36	.46
						Achieved	2.49	2.32	Achieved	.68	.83
Forestry	17	64	162	.22	.42	Predicted	2.19	2.21	Predicted	.26	.24
						Achieved	2.38	2.23	Achieved	.73	.71
Geography	18	572	1401	.51	.49	Predicted	2.11	2.27	Predicted	.41	.44
						Achieved	2.31	2.22	Achieved	.76	.92
Geology	19	589	1094	.39	.41	Predicted	2.27	2.30	Predicted	.35	.38
						Achieved	2.17	2.20	Achieved	.78	.91
History	20	961	1049	.51	.43	Predicted	2.33	2.44	Predicted	.34	.34
						Achieved	2.23	2.36	Achieved	.74	.83
Journalism	21	101	545	.23	.31	Predicted	2.83	2.76	Predicted	.30	.33
						Achieved	2.75	2.76	Achieved	.77	.73

Table 6. Continued.

Course	Area	N		r			Mean			Standard Deviations	
		WSU	UW	WSU	UW		WSU	UW		WSU	UW
Home Econ.	22	320	745	.49	.46	Predicted	2.69	2.78	Predicted	.25	.29
						Achieved	2.37	2.81	Achieved	.70	.74
Languages	23	344	790	.50	.58	Predicted	2.69	2.36	Predicted	.53	.60
						Achieved	2.37	2.31	Achieved	.84	1.12
Math	24	1246	2377	.46	.53	Predicted	2.17	2.11	Predicted	.55	.55
						Achieved	2.21	1.98	Achieved	.89	1.01
Music	25	472	816	.05	.27	Predicted	2.97	3.00	Predicted	.18	.19
						Achieved	3.14	2.99	Achieved	.77	.69
Nursing	26	58	219	.59	.36	Predicted	2.71	2.77	Predicted	.27	.23
						Achieved	2.78	2.75	Achieved	.81	.68
Nutrition	27	164	199	.53	.52	Predicted	2.65	2.66	Predicted	.49	.44
						Achieved	2.66	2.64	Achieved	.80	.78
Pharmacy	28	30	109	-.16	.34	Predicted	2.26	2.04	Predicted	.33	.40
						Achieved	2.78	1.96	Achieved	.66	.86
Philosophy	29	545	619	.45	.49	Predicted	2.43	2.50	Predicted	.39	.42
						Achieved	2.17	2.43	Achieved	.85	.91
Physics	30	233	1336	.34	.41	Predicted	2.27	2.26	Predicted	.29	.31
						Achieved	2.28	2.16	Achieved	.77	.87
Political Sci.	31	644	790	.50	.49	Predicted	2.38	2.40	Predicted	.44	.40
						Achieved	2.08	2.36	Achieved	.76	.88

Psychology	32	1516	2142	.54	.54	Predicted	2.13	2.24	Predicted	.54	.53
						Achieved	2.39	2.25	Achieved	.90	.92
Radio & TV	33	59	184	.45	.43	Predicted	2.69	2.83	Predicted	.40	.39
						Achieved	3.01	2.67	Achieved	.70	.75
Sociology	34	1541	2741	.59	.60	Predicted	2.35	2.34	Predicted	.53	.54
						Achieved	2.26	2.28	Achieved	.82	.92
Speech	35	657	1704	.46	.46	Predicted	2.48	2.62	Predicted	.39	.40
						Achieved	2.53	2.63	Achieved	.71	.75
Zoology	36	749	875	.46	.49	Predicted	2.13	2.18	Predicted	.47	.46
						Achieved	2.14	2.07	Achieved	.88	1.00

taken from a published report.[1] Table 7 shows the ranking of predicted grades, the achieved grades, and the predicted-achieved grades. A rank-correlation coefficient of .89 was found for the predicted grades.

The rank-correlation coefficient of .89 showed a definite hierarchy for the means of the predicted grades which was common to both student groups. Two criterion areas, Economics with means of 2.28 and 2.67 and Romance Languages with means of 2.69 and 2.36, accounted for much of the variation in the ranking of the predicted grades.

The rank-correlation coefficient for the achieved grades was .57, a greater variation in internal ranking than the predicted grades.

The lower correlation was primarily a result of differences in ranking for seven criterion areas, Bacteriology, Botany, English Composition, Home Economics, Pharmacy, Philosophy, and Political Science. There were no trends or direction to show whether one group had mean grades higher or lower than the other group.

The rank-correlation coefficient for the means of the predicted grades and the means of the achieved grades for the Washington State University sample was .57. The criterion areas of Accounting, Anthropology, Forestry, Geography, Pharmacy, Philosophy, Political Science, and

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[1] "Validity Coefficients for 1955-1956 Weights," Duplicated Report, University of Washington Division of Counseling and Testing Services, July, 1959.

Table 7. Rank-order correlations of predicted grades for the 1961 Washington State University freshmen, and University of Washington 1955-1956 freshmen.

Criterion Area	Mean		Rank			
	W.S.U.	U.W.	W.S.U.	U.W.	Diff.	$(Diff)^2$
All-University	2.27	2.28	14	11	3	9.00
Accounting	2.31	2.31	17	14.5	2.5	6.25
Anthropology	2.50	2.44	26	23.5	2.5	6.25
Architecture	2.35	2.33	20.5	17	3.5	12.25
Art	2.60	2.65	28	27	1	1.00
Bacteriology	2.27	2.30	14	12.5	1.5	2.25
Biology	2.09	2.17	1	6	5	25.00
Botany	2.21	2.02	8	1	7	49.00
Business Admin.	2.25	2.33	10	17	7	49.00
Chemistry	2.10	2.09	2	3	1	1.00
*Economics	2.28	2.67	16	29	13	269.00
Drama	2.66	2.73	30	30.5	.5	.25
Education	2.53	2.73	27	30.5	2.5	6.25
Engineering	2.22	2.31	9	14.5	5.5	30.25
English Comp.	2.39	2.33	23	17	6	36.00
English Lit.	2.33	2.40	18.5	21.5	3	9.00
Forestry	2.19	2.21	7	7	0	0
Geography	2.11	2.27	3	10	7	49.00
Geology	2.27	2.30	13	12.5	1.5	2.25
History	2.33	2.44	18.5	23.5	5	25.00
Journalism	2.83	2.76	35	32	3	9.00
Home Economics	2.69	2.78	32	34	2	4.00
*Languages	2.69	2.36	32	20	12	244.00
Mathematics	2.17	2.11	6	4	2	4.00
Music	2.97	3.00	36	36	0	0
Nursing	2.71	2.77	34	33	1	1.00
Nutrition	2.65	2.66	29	28	1	1.00
Pharmacy	2.26	2.04	11	2	9	81.00
Philosophy	2.43	2.50	24	25	1	1.00
Physics	2.27	2.26	13	9	4	4.00
Political Sci.	2.38	2.40	22	21.5	.5	.25
Psychology	2.13	2.24	4.5	8	3.5	12.25
Radio & TV	2.69	2.83	32	35	3	9.00
Sociology	2.35	2.34	20.5	19	1.5	2.25
Speech	2.48	2.62	25	26	1	1.00
Zoology	2.13	2.14	4.5	5	.5	.25
						962.00

$$r^1 = \frac{1 - 6\ (962.00)}{36\ (1295)} = r^1 = 1 - \frac{962.00}{6\ (1295)}$$

$$r^1 = 1 - \frac{962.00}{7770} = r^1 = 1 - .12 = .888$$

Table 7. Continued. Rank-order correlations of achieved grades for the 1961 Washington State University freshmen, and University of Washington 1955-1956 freshmen.

Criterion Area	Mean		Rank			
	W.S.U.	U.W.	W.S.U.	U.W.	Diff.	$(Diff)^2$
All-University	2.16	2.21	6	12	6	36.00
Accounting	2.00	2.11	1	6	5	30.00
Anthropology	2.23	2.24	13	15	2	4.00
Architecture	2.72	2.44	30	24	6	36.00
Art	2.34	2.55	19	26	7	49.00
*Bacteriology	2.15	2.47	5	25	20	400.00
Biology	2.19	2.14	9	7.5	1.5	2.25
*Botany	2.23	1.93	13	1	12	144.00
Business Admin.	2.20	2.33	10	20	10	100.00
Chemistry	2.12	2.00	3	4	1	1.00
Economics	2.24	2.14	15	7.5	7.5	56.25
Drama	2.73	2.81	31	34.5	3.5	12.25
Education	2.48	2.57	25	27	2	4.00
Engineering	2.35	2.33	20	20	0	0
*English Comp.	2.68	2.19	29	10	19	361.00
English Lit.	2.49	2.32	26	19	7	49.00
Forestry	2.38	2.23	23	14	9	81.00
Geography	2.31	2.22	18	13	5	25.00
Geology	2.17	2.20	7.5	11	3.5	12.25
History	2.23	2.36	13	21.5	8.5	72.25
Journalism	2.75	2.76	32	32	0	0
*Home Economics	2.37	2.81	21.5	33.5	12	144.00
Languages	2.37	2.31	21.5	18	3.5	12.25
Mathematics	2.21	1.98	11	3	8	64.00
Music	3.14	2.99	36	35	1	1.00
Nursing	2.78	2.75	33.5	31	2.5	6.25
Nutrition	2.66	2.64	28	29	1	1.00
*Pharmacy	2.78	1.96	33.5	2	31.5	992.25
*Philosophy	2.17	2.43	7.5	23	15.5	240.25
Physics	2.28	2.16	17	9	8	64.00
*Political Sci.	2.08	2.36	2	21.5	19.5	380.25
Psychology	2.39	2.25	24	16	8	64.00
Radio & TV	3.01	2.67	35	30	5	25.00
Sociology	2.26	2.28	16	17	1	1.00
Speech	2.53	2.63	27	28	1	1.00
Zoology	2.14	2.07	4	5	1	1.00
						3,373.90

$$r^1 = \frac{1 - 6\ (3373.90)}{36\ (1295)} \qquad r^1 = \frac{1 - 3373.90}{7770.00}$$

$$r^1 = 1 - .43 \qquad r^1 = .57$$

Table 7. Continued. Rank-order correlations of achieved and predicted grades for the 1961 Washington State University freshmen.

Criterion Area	Mean		Rank		Diff.	$(Diff)^2$
	Pred.	Ach.	Pred.	Ach.		
All-University	2.27	2.16	14	6	8	64.00
*Accounting	2.31	2.00	17	1	16	256.00
*Anthropology	2.50	2.23	26	13	13	169.00
Architecture	2.35	2.72	20.5	30	9.5	90.25
Art	2.60	2.34	28	19	9	81.00
Bacteriology	2.27	2.15	14	5	9	81.00
Biology	2.09	2.19	1	9	8	64.00
Botany	2.21	2.23	8	13	5	25.00
Business Admin.	2.25	2.20	10	10	0	0
Chemistry	2.10	2.12	2	3	1	1.00
Economics	2.28	2.24	16	15	1	1.00
Drama	2.66	2.83	30	34	4	16.00
Education	2.53	2.48	27	25	2	4.00
Engineering	2.22	2.35	9	21.5	8.5	72.25
English Comp.	2.39	2.68	23	29	6	36.00
English Lit.	2.33	2.49	18.5	26	7.5	56.25
*Forestry	2.19	2.38	7	23	16	256.00
*Geography	2.11	2.31	3	18	15	225.00
Geology	2.27	2.17	13	7.5	5.5	32.25
History	2.33	2.23	18.5	13	5.5	32.25
Journalism	2.83	2.75	38	31	7	49.00
Home Economics	2.69	2.37	32	21.5	10.5	110.25
Languages	2.69	2.37	32	21.5	10.5	110.25
Mathematics	2.17	2.21	6	11	5	25.00
Music	2.97	3.14	36	36	0	0
Nursing	2.71	2.78	34	32.5	1.5	2.25
Nutrition	2.65	2.66	29	28	1	1.00
*Pharmacy	2.26	2.78	11	32.5	21.5	462.25
*Philosophy	2.43	2.17	24	7.5	16.5	272.25
Physics	2.27	2.28	13	17	4	16.00
*Political Sci.	2.38	2.08	22	2	20	400.00
*Psychology	2.13	2.39	4.5	24	19.5	380.25
Radio & TV	2.69	3.01	32	35	3	9.00
Sociology	2.35	2.26	20.5	16	3.5	12.25
Speech	2.48	2.53	25	27	2	4.00
Zoology	2.13	2.14	4.5	4	.5	.25
						3,416.55

$$r^1 = \frac{1 - 6\ (3416.55)}{36\ (1295)} \qquad r^1 = \frac{1 - 3416.55}{7770.00}$$

$$r^1 = 1 - .43 \qquad = \qquad r^1 = .57$$

Psychology showed the greatest variation in their rankings. Again there were no trends or direction as to whether the predicted or achieved grades for one group were higher or lower than for the other group.

4. Are the present predictor equations used in the Washington Pre-College Testing Program valid for Washington State University students or should there be developed predictor equations based on the grades achieved by students at Washington State University?

This, the principal part of the present study, was designed to determine the validity of the predicted grades of the Washington Pre-College Testing Program for students at Washington State University. A comparison was made of the multiple regression prediction equations used in the Washington Pre-College Testing Program with the multiple regression prediction equations developed by using achieved grades at Washington State University as the criterion variables. Table A in the Appendix presents the symmetric correlation matrix for the 18 predictor variables and a non-symmetric correlation matrix for the 18 predictors and 36 criterion areas of achieved grade summaries for the 1958-1960 freshmen at Washington State University. A multiple regression program was used, using the Washington State University matrices as input, following the Horst iteration of a single criterion. Table 8 is the iteration order of selection of predictors in each of the 36 criterion areas and the cumulative squared multiple correlations at each successive iteration. For each criterion area the predictors are shown as selected and at what iteration step. The new

Table 8. Order of selection of predictor and cumulative squared adjusted multiple correlations for each of the differential predictor measures as given in the "Iterative Predictor Selection Program" for each of thirty-six criteria of academic success at Washington State University.

Criterion -- All University				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.543800	.54350964
2	2	12	.200524	.57907788
3	3	6	.083881	.58487399
4	5	5	.119242	.60719971
5	7	2	.083719	.61795592
6	9	18	.068412	.62369416
7	11	4	.047127	.62646857
8	13	9	.040984	.62927384
9	14	10	-.028985	.62970377
10	15	8	-.033965	.63022728
11	16	7	.031978	.63080583
12	19	14	.029596	.63321219
13	20	3	.020933	.63332590
14	33	11	.016508	.63736877

Table 8. Continued.

Criterion -- Accounting				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	2	.400375	.39752322
2	2	11	.162081	.42679004
3	4	5	.086437	.44054891
4	5	6	-.067288	.44323643
5	6	15	.069757	.44630671
6	7	10	-.065393	.44846324
7	8	13	.070016	.45153063
8	10	3	.050717	.45367554
9	11	8	.044939	.45292850
10	13	9	-.048677	.45669355
11	14	17	.051443	.45716441

Table 8. Continued.

Criterion -- Anthropology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.406312	.40529174
2	2	12	.225424	.46297771
3	3	15	-.128469	.47970925
4	4	2	.073366	.48451932
5	6	3	.090708	.50209240
6	8	7	.074880	.51035780
7	9	5	.044552	.51159144
8	11	17	.041423	.51596111
9	15	8	-.022223	.52022403
10	18	11	-.018880	.52062798
11	19	16	.021375	.52028985

Table 8. Continued.

Criterion -- Architectural Engineering				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	11	.404629	.38936404
2	2	14	-.350277	.51519942
3	3	6	.238554	.56028817
4	4	7	-.242096	.60472323
5	5	4	.206013	.63374901
6	6	10	-.119005	.63729180
7	7	9	.107577	.63977052
8	8	15	-.110158	.64281743
9	9	13	-.093038	.64284153
10	11	5	-.093800	.64762837
11	13	3	-.079563	.65054823

Table 8. Continued.

Criterion -- Art				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.340438	.33844057
2	2	16	.175038	.37936026
3	3	15	-.097642	.39009634
4	4	13	.066458	.39409734
5	6	4	.081417	.40638774
6	7	14	.054940	.40854255
7	9	6	.060668	.41467071
8	10	11	-.036478	.41474707
9	12	10	-.036184	.41576301
10	13	7	.031140	.41538573
11	14	18	-.032605	.41512136
12	15	3	.028449	.41454426
13	17	1	.028589	.41521761
14	18	9	-.029625	.41472313
15	23	12	.016272	.41597682
16	30	8	.015311	.41369939
17	31	2	-.015195	.41220487
18	63	17	.003643	.41309649

Table 8. Continued.

Criterion -- Bacteriology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.421030	.41959044
2	2	2	.122890	.43587729
3	3	15	-.085390	.44285209
4	4	7	.078124	.44840823
5	6	3	.091800	.46588144
6	8	4	.053995	.47140933
7	9	14	-.043390	.47220236
8	10	13	-.045444	.47319149
9	11	17	.032099	.47304209
10	12	12	-.040723	.47359447
11	13	16	.033408	.47356617

Table 8. Continued.

Criterion -- Biology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	4	.417988	.41616949
2	2	12	.157774	.44346217
3	3	2	.101468	.45335339
4	5	5	.097116	.47709004
5	6	1	-.084665	.48313474
6	8	8	.057468	.48800746
7	9	9	.029421	.48734207
8	13	17	.022501	.49011051
9	15	3	.029362	.49029619
10	16	13	-.024438	.48935480
11	20	6	-.017884	.48952340

Table 8. Continued.

Criterion -- Botany				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	2	.428503	.42677099
2	2	11	.177337	.46066171
3	4	5	.124324	.48397329
4	6	7	.076764	.94550371
5	7	15	-.072179	.49940164
6	8	6	.063066	.50204417
7	10	4	.040997	.50457297
8	11	13	-.030466	.50414828
9	12	14	-.029079	.05363830
10	14	8	-.032963	.50313167
11	18	1	.022391	.50432664

Table 8. Continued.

Criterion -- Business Administration				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	4	.300948	.29757854
2	2	13	.156670	.33344004
3	3	12	.066859	.33719841
4	5	4	.069442	.34804916
5	6	9	-.058407	.35017370
6	7	7	.047306	.35060293
7	9	3	.054758	.35398923
8	10	10	-.037693	.35294836
9	11	2	.030061	.35141366
10	13	1	.032188	.35258957
11	14	18	-.029747	.35101791

Table 8. Continued.

Criterion -- Chemistry				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.439731	.43886931
2	2	11	.213676	.48743261
3	3	8	-.083552	.49375605
4	4	12	.079526	.49940522
5	6	2	.081651	.51542231
6	8	3	.045892	.51958619
7	9	15	-.045465	.52089929
8	14	10	.020494	.52492080
9	15	17	-.024374	.52481446
10	20	14	-.018121	.52654640
11	21	16	-.011748	.52600376
12	26	4	.013307	.52627366
13	27	1	-.011381	.52572121
14	44	7	-.003518	.52605747
15	70	18	.001540	.52558574
16	90	9	-.000582	.52492425

Table 8. Continued.

Criterion -- Drama				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.246807	.23476953
2	2	10	-.086641	.23842772
3	3	11	.090829	.24341080
4	4	13	-.111537	.25700213
5	5	9	.102386	.26630462
6	7	6	.060656	.26836891
7	11	15	.043949	.27394244
8	12	5	-.044037	.26660503
9	14	16	-.035972	.25982723
10	15	3	.033160	.25009455
11	16	2	-.039729	.24089900

Table 8. Continued.

Criterion -- Economics				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.357997	.35651239
2	2	12	.208269	.41172431
3	4	17	.090715	.42609394
4	5	3	.046278	.42744029
5	7	4	.054680	.43412621
6	9	11	.052370	.43866357
7	10	15	.042789	.43963516
8	12	8	.037989	.44219756
9	14	2	.032802	.44378062
10	15	16	-.041149	.44455067
11	17	14	-.026457	.44540717

Table 8. Continued.

Criterion -- Education				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.465104	.46397778
2	2	12	.154892	.48813867
3	3	10	-.097651	.49679755
4	4	5	.093799	.50461327
5	6	17	.085633	.51492804
6	7	15	.066696	.51830342
7	9	4	.070396	.52556349
8	13	13	.031340	.53156631
9	16	2	.030784	.53377187
10	18	18	.029616	.53440336
11	19	16	-.026030	.53413358

Table 8. Continued.

Criterion -- Engineering				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	6	.297920	.29453956
2	2	15	.157898	.33133601
3	3	5	.117978	.34904056
4	5	8	.072953	.36623237
5	6	9	.082653	.37291751
6	7	11	-.076542	.37821294
7	8	2	.060599	.38055156
8	9	10	-.069950	.38450633
9	11	7	-.049275	.38753793
10	12	12	.049754	.38828391
11	15	3	.033382	.39226837

Table 8. Continued.

Criterion -- English Composition				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.401834	.39969428
2	2	14	.090699	.40779135
3	3	10	.088673	.41527244
4	4	6	.055630	.41695879
5	6	17	.059524	.42477129
6	7	13	-.049444	.42567413
7	8	2	.050508	.42670525
8	10	3	.037851	.42867203
9	11	8	-.029671	.42627499
10	13	5	.036054	.42714912
11	16	15	-.019338	.42713969

Table 8. Continued.

Criterion -- English Literature				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.370076	.36887041
2	2	12	.166641	.40373215
3	3	15	-.086626	.41189969
4	4	10	-.048115	.41366144
5	5	16	.065578	.41782403
6	6	6	.041865	.41890527
7	8	4	.048063	.42347828
8	9	13	-.045048	.42488154
9	10	2	.034476	.42528658
10	12	9	.042520	.42908883
11	14	17	.032988	.43138982
12	16	7	.035965	.43395641
13	17	11	-.027522	.43384755

Table 8. Continued.

Criterion -- Foods and Nutrition				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.433131	.42855409
2	2	12	.153318	.45101226
3	3	10	-.079275	.45361894
4	4	5	.099191	.46027529
5	6	6	.083631	.47022087
6	7	13	.052497	.46907644
7	8	16	-.072300	.47064377
8	9	17	.064431	.47103481
9	11	3	.062258	.47427278
10	15	11	.035786	.47604737
11	16	18	-.027173	.47266780

Table 8. Continued.

Criterion -- Forestry				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.541687	.52947175
2	2	16	.244756	.57352227
3	3	7	-.145392	.58170509
4	4	14	-.131486	.58655975
5	6	3	-.127416	.59948212
6	7	9	.097821	.59753283
7	8	11	-.121497	.60047052
8	9	8	.079898	.58993882
9	10	12	-.074084	.58266866
10	11	18	.098543	.57948195
11	12	6	.067661	.57044333

Table 8. Continued.

Criterion -- Geography				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	4	.355227	.35322759
2	2	12	.189989	.39945189
3	3	8	.099808	.40961568
4	4	9	-.056481	.41170531
5	5	17	.068244	.41557682
6	7	1	.059786	.42166279
7	9	16	.036081	.42424842
8	13	11	.036241	.42930075
9	22	15	.021372	.43368591
10	23	3	.014707	.43223546
11	28	10	-.014004	.43179864

Table 8. Continued.

Criterion -- Geology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	11	.372391	.37070156
2	2	5	.157697	.40137444
3	3	10	-.079484	.40765521
4	4	4	.076520	.41332706
5	6	18	.071417	.42182422
6	8	2	.050074	.42557684
7	9	3	-.053447	.42753387
8	10	16	.045914	.42860506
9	12	13	.044954	.43265752
10	13	9	-.037797	.43293112
11	16	14	-.037846	.43681534
12	17	7	.032126	.43663134

Table 8. Continued.

Criterion -- History				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	12	.388764	.38768669
2	2	4	.231090	.45052270
3	4	5	.089346	.46630211
4	5	14	-.059578	.46928449
5	6	10	-.047732	.47086291
6	7	17	.068654	.47505373
7	9	16	.044050	.48000898
8	11	2	.036126	.48205299
9	14	13	-.031722	.48385040
10	15	1	.021566	.48354191
11	18	15	-.027922	.48482036

Table 8. Continued.

Criterion -- Home Economics				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.424794	.42235729
2	2	6	.146922	.44497853
3	3	11	.119842	.45871171
4	5	1	.105687	.48165176
5	6	10	-.079585	.48619890
6	7	7	.097604	.49405987
7	9	3	.062701	.50216646
8	11	9	.057407	.50646402
9	13	12	.040837	.50851431
10	14	16	-.042501	.50843824
11	15	17	.038527	.50803582
12	18	18	-.031802	.50951017
13	19	8	.034269	.50472387
14	21	2	-.033013	.50426900
15	22	4	.027649	.50277779
16	27	14	.020850	.50363987
17	29	13	.018870	.50210542
18	38	15	-.018759	.50277317

Table 8. Continued.

Criterion -- Journalism				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	3	.404787	.39700413
2	2	17	.199091	.43762073
3	3	8	.143534	.45260813
4	4	6	.124386	.46283419
5	5	11	-.115689	.47070002
6	6	15	-.094437	.47363853
7	7	9	.094143	.47654683
8	9	7	.063383	.48273512
9	10	18	-.072553	.48170517
10	13	12	.065601	.48514450
11	14	14	.045974	.48053910

Table 8. Continued.

Criterion -- Language				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	3	.397947	.39513963
2	2	9	.154683	.42184208
3	3	8	-.120060	.43515046
4	5	12	.105638	.45630578
5	7	15	-.033587	.45625684
6	8	2	.029598	.45456147
7	10	10	.035410	.45541570
8	14	4	-.036002	.45754044
9	15	14	-.025338	.45557407
10	16	18	.022209	.45341775
11	19	11	-.016060	.45181151

Table 8. Continued.

Criterion -- Mathematics				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	2	.383695	.38273409
2	2	8	-.182626	.42320703
3	3	11	.109898	.43643726
4	4	15	.081834	.44325054
5	6	5	.067657	.45145568
6	10	18	.038077	.45988353
7	12	10	-.023799	.46034233
8	13	1	.025912	.46030504
9	14	9	-.023470	.46013557
10	15	13	.020257	.45981161
11	18	17	-.016188	.46031372
12	22	16	-.015769	.46062940
13	28	14	-.009578	.46093982
14	30	7	.010111	.46036660
15	40	12	.007454	.46045269
16	48	6	.005011	.45996642
17	58	3	.003578	.45932654

Table 8. Continued.

Criterion -- Music				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	3	.154475	.14978446
2	2	13	.083085	.16711499
3	3	6	.044110	.16868997
4	4	15	-.053330	.17288855
5	5	17	-.045627	.17472730
6	6	7	.061891	.18154901
7	7	12	-.049312	.18434817
8	8	18	.047079	.18648566
9	11	2	-.039127	.19625052
10	12	4	.037362	.19620919
11	15	5	-.027406	.19916067
12	18	1	.024993	.20082625
13	19	9	-.025298	.19886424
14	22	14	-.021134	.19885284
15	24	16	-.016850	.19683372
16	37	10	.013025	.20079640
17	38	8	.012150	.18879987
18	58	11	-.004575	.18801481

Table 8. Continued.

Criterion -- Nursing				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	4	.454165	.43596708
2	2	18	.190925	.45952698
3	3	8	.135375	.45635761
4	4	12	-.140051	.45878057
5	5	10	.141866	.46193448
6	6	7	-.115377	.45669876
7	7	2	.121966	.45316974
8	8	1	-.107225	.44482497
9	9	9	.093429	.43185537
10	10	16	-.073999	.41266993
11	12	13	-.058320	.39812897

Table 8. Continued.

Criterion -- Pharmacy				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	14	-.424632	.39226401
2	2	1	.316860	.48245247
3	3	15	.161702	.48492921
4	4	2	-.168728	.49028217
5	5	11	.182563	.50174059
6	6	16	-.103314	.48590287
7	7	18	.154236	.48579359
8	10	8	.089476	.48424373
9	14	10	.050532	.47840752
10	15	3	-.071944	.44698327
11	18	7	.045804	.41970519

Table 8. Continued.

Criterion -- Philosophy				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.379832	.37788121
2	2	18	.205496	.42856318
3	4	12	.079599	.43881320
4	5	8	-.067889	.44192544
5	6	1	-.031150	.44129912
6	7	9	.044111	.44178758
7	9	11	.027001	.44196150
8	11	4	.028505	.44204358
9	13	7	.023981	.44167249
10	15	3	.019476	.44073573
11	17	17	.017747	.43969443

Table 8. Continued.

Criterion -- Physics				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.334599	.32909263
2	2	9	.123991	.34658063
3	3	17	-.122952	.36300476
4	4	16	.117341	.37703218
5	5	6	-.116487	.39040615
6	6	8	.069993	.39204830
7	10	13	.068032	.41129471
8	11	7	.032838	.40832335
9	13	12	.041969	.40975450
10	14	10	-.028875	.40642568
11	15	3	.027570	.40294438
12	16	2	-.034169	.39993838
14	26	15	.021662	.39886986
15	29	4	-.014510	.39519874
16	32	11	.013723	.39133085
17	49	1	.008165	.38847767
18	51	14	.006255	.38369904

Table 8. Continued.

Criterion -- Political Science				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	4	.434103	.43276989
2	2	12	.199680	.47551351
3	4	2	.109670	.49244645
4	6	5	.080624	.50219073
5	8	18	.068923	.50872286
6	9	8	-.053772	.50989114
7	10	9	-.041341	.51042815
8	11	16	.050132	.51176257
9	13	7	.026282	.51253666
10	17	15	.029088	.51542827
11	18	17	.019865	.51467387

Table 8. Continued.

Criterion -- Psychology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	2	.401157	.40043091
2	2	12	.269003	.48189551
3	4	4	.116362	.50296156
4	6	7	.085041	.51425799
5	7	15	-.053626	.51656026
6	8	5	.052563	.51874625
7	10	18	.042705	.52416722
8	13	10	-.035031	.52844809
9	14	14	-.025376	.52858161
10	15	6	-.022952	.52860373
11	16	3	.025035	.52872113
12	18	17	.024301	.52922079
13	21	8	-.014564	.52920029

Table 8. Continued.

Criterion -- Radio & TV				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	12	.233164	.18828889
2	2	2	-.224400	.26111037
3	3	3	.260343	.34753428
4	5	6	.202375	.41973748
5	6	8	.167408	.43513450
6	7	13	-.159563	.44741742
7	8	10	.159283	.45979562
8	9	14	-.126950	.46063796
9	10	9	-.132600	.46344391
10	11	11	.160209	.47702806
11	12	15	.166496	.49354734
12	15	16	-.125227	.53353426
13	16	18	.107529	.53042644

Table 8. Continued.

Criterion -- Speech				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	1	.400286	.39903669
2	2	10	-.201328	.44590480
3	3	7	.242497	.50683349
4	5	9	.180641	.55200262
5	9	6	.057896	.57297605
6	10	18	.033233	.57323543
7	12	3	.045040	.57602455
8	14	15	.043071	.57782816
9	15	13	.026992	.57776346
10	17	14	-.019893	.57815708
11	18	4	.018091	.57774079
12	24	17	-.016577	.57879584
13	29	11	.011011	.57881104
14	34	2	-.007419	.57839946
15	38	12	-.006283	.57789951
16	41	8	.005966	.57634125
17	54	16	-.002876	.57584268

Table 8. Continued.

Criterion -- Sociology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.458901	.45835336
2	2	12	.276629	.53498065
3	4	7	.134511	.56058103
4	6	2	.067913	.56674068
5	8	17	.060527	.57173360
6	9	10	-.054211	.57391402
7	10	18	.031180	.57438748
8	12	11	.032819	.57622112
9	13	14	.032128	.57674707
10	15	6	.042452	.57865546
11	16	9	.022286	.57871565
12	18	5	.025296	.57975272
13	19	13	-.027242	.58002703
14	20	15	-.025357	.58021533
15	21	8	-.031934	.58012041

Table 8. Continued.

Criterion -- Zoology				
Order of Predictor Selection	Iteration Number	Predictor Selected	Accretion to Beta	Cumulative Squared Adjusted Multiple Correlation
1	1	5	.421329	.41989766
2	2	11	.156245	.44675539
3	3	3	.088524	.45418728
4	5	2	.078134	.47223729
5	7	7	.060267	.47769335
6	8	14	.035089	.47780192
7	10	1	-.042425	.47975972
8	11	8	-.035969	.47917130
9	12	16	.025318	.47856113
10	14	15	-.033174	.47917056
11	17	9	.022055	.48027775

predictor beta weights (B's) are found in Table 9. The raw score predictor weights (b's), a product of the iteration procedure and used in developing new predictions of grade points, are found in Table 10.

Table 11 is the product moment correlations and their t-values for the Z-transformation of the correlation when a comparison of the two predicted grade points was made with the achieved grade-point average. The criterion area All-University showed no statistically significant difference between the two predicted grade points in their correlation with the achieved grade-point average. No significant differences were found for Accounting, Anthropology, Bacteriology, Business Administration, Chemistry, Economics, Education, English Composition, English Literature, Geography, History, Home Economics, Language, Mathematics, Music, Nutrition, Philosophy, Political Science, Psychology, Radio & TV, Sociology, Speech, and Zoology.

Statistically significant differences were found between the predicted grade points from the Washington State University sample and the predicted grade points from the Washington Pre-College Testing Program for the criterion areas of Architecture, Art, Biology, Botany, Drama, Engineering, Forestry, Geology, Journalism, Nursing, Pharmacy, and Physics. Three areas, Biology, Drama, and Nursing have a higher correlation for the predicted grade point from the Washington Pre-College Testing Program.

Table 9. Multiple regression beta weights for 1958-1960 differential predictions of thirty-six criteria of academic success at the Washington State University.

Criterion No.	Measures	Number of Cases	Predictor Measures: High School English (1)	High School Mathematics (2)	High School Foreign Languages (3)	High School Social Sciences (4)
1.	All Univ.	2031	.1022	.0952	.0475	.1067
2.	Accounting	356		.1710	.0965	
3.	Anthro.	907		.0928	.1035	.1264
4.	Arch. Eng.	69				.3799
5.	Art	581				.1360
6.	Bact.	681		.1597	.1149	.0810
7.	Biology	545	-.1759	.1575	.0489	.2471
8.	Botany	512		.1611		.0292
9.	Bus. Admin.	450	.0605	.0759	.0699	.0634
10.	Chemistry	1029		.1315	.0614	
11.	Economics	790		.0328	.0526	.1095
12.	Drama	140	.2021		.0603	
13.	Education	646	.1803	.0369		.1595
14.	Engineer.	446		.1015		
15.	Eng. Comp.	451	.1608	.0763	.0458	
16.	Eng. Lit.	846	.1665	.0808		.1013
17.	Forestry	53	.4755		-.1118	
18.	Geography	611	.1641		.0230	.1708
19.	Geology	627		.1669	-.0707	.0839
20.	History	1008	.0671	.0635		.1245
21.	Journalism	125			.2855	
22.	Home Econ.	395	.1734		.0929	
23.	Language	332		.1064	.2326	-.0568
24.	Math.	1118	.0619	.1814		
25.	Music	682		-.0748	.1106	.0739
26.	Nursing	51	-.2411	.1984		.4686
27.	Nutrition	188	.2100		.1089	
28.	Pharmacy	30	.4831	-.3656	-.1423	
29.	Philosophy	531	-.1205		.0376	.0718
30.	Physics	245				
31.	Pol. Sci.	635		.1329		.1599
32.	Psychology	1300		.1507	.0408	.1241
33.	Radio/TV	51		-.6660	.3605	
34.	Sociology	1403		.0662		.2144
35.	Speech	766	.2649		.0899	
36.	Zoology	676	-.1050	.1613	.1822	

Predictor Measures						
High School Natural Science	High School Electives	G. - Z. Verbal	G. - Z. Mechanical	English Usage	Spelling	Mathematics
5	6	7	8	9	10	11
.1305	.1218	.0715	-.0534	.0683	-.0651	
.1386	-.0912		.1271	-.0919	-.0858	.2619
.1221		.0976	-.0265			-.0397
-.1679	.1942	-.3575		.3455	-.1829	.3563
.1704	.0730	.0955			-.0549	-.0721
.1937		.0966				
.1662			.0606	.0674		
.1871	.0813	.0821	-.0869			.1875
.0992		.0882		-.1121	-.0437	
.2339			-.1761		.0309	.1710
.1146			.1126			.1022
-.0707	.0648			.1550	-.1849	.2459
.1106					-.1476	
.1279	.1472	-.1094	.1955	.1788	-.0775	-.1638
.0517	.0948		-.0555		.0841	
	.0617	.0544		.0916	-.1263	
		-.3075	.1267	.2237		-.1982
			.0682	-.1931		.0825
.0939				-.0781	-.1192	.1929
.0811					-.1094	
	.1994	.1055	.1452	.1787		-.2599
.1331	.1338	.1402		.0989	-.2013	.1286
			-.2278	.0791	.0680	
.0927			-.1819	-.0524	-.0311	.2095
	.0822	.1169				
		-.1397	.1710	.1484	.2308	
.1233	.0946				-.0792	.0282
			.2125		.0998	.3554
.2623		.0320	-.0827	.0677		.0328
.3148	-.1214	.0835	.0629	.2271	-.0437	
.1439		.0419	-.0550	-.1155		
.1197	-.0316	.1179			-.0553	
	.2393		.4257	-.3055	.2836	.4799
.0479	.0518	.1632		.0628	-.0835	.0312
	.0665	.2346		.2646	-.5303	

Table 9. Continued.

No.	Measures	Number of Cases	Predictor Measures: Social Studies	A.C.E.-Q	Age	Sex
			12	13	14	15
1.	All Univ.	2031	.1117		.0296	
2.	Accounting	356		.0905		.2617
3.	Anthro.	907	.1337			-.2036
4.	Arch. Eng.	69		-.1057	-.3348	-.1966
5.	Art	581		.1443	.0515	.0997
6.	Bact.	681	-.0765	-.0700	-.0489	-.1310
7.	Biology	545	.1056	-.0382		
8.	Botany	512		-.0388	-.0269	-.1737
9.	Bus. Admin.	450	.0725	.1347		
10.	Chemistry	1029	.1367		-.0193	-.1359
11.	Economics	790	.1394			.1530
12.	Drama	140		-.1990		.0805
13.	Education	646	.1009	.0443		.1294
14.	Engineer.	446	.0833			.2249
15.	Eng. Comp.	451		-.0829	.0982	
16.	Eng. Lit.	846	.0733	-.0823		-.0798
17.	Forestry	53	-.1583		-.1252	
18.	Geography	611	.1309			.0301
19.	Geology	627		.0568	-.0385	
20.	History	1008	.1934	-.0466	-.0579	
21.	Journalism	125	.0782			-.1989
22.	Home Econ.	395	.0685			
23.	Language	332	.1158		-.0246	-.0635
24.	Math.	1118		.0276		.1294
25.	Music	682	-.0814	.1153		-.0616
26.	Nursing	51	-.1524			
27.	Nutrition	188	.1517	.0573		
28.	Pharmacy	30			-.3939	.4586
29.	Philosophy	531	.0836			
30.	Physics	245	.0527	.0810		
31.	Pol. Sci.	635	.1410			.0416
32.	Psychology	1300	.1507		-.0253	.0703
33.	Radio/TV	51	.3296	-.2287	-.1445	.5014
34.	Sociology	1403	.1422	-.0489	.0299	-.0421
35.	Speech	766		.0327	-.0184	.0657
36.	Zoology	676			.0366	-.0722

Predictor Measures		
A.C.E.-L	Coop - Speed	Coop - Level
16	17	18
		.0773
	.0825	
.0925		
	.0782	
	.0468	
	.0506	
-.0810	.1245	
-.0472		
	.0851	.0447
	.1067	
.0720	.0610	
.4959		.1372
.0673	.1013	
.0977		.0772
.0888	.1236	
	.1778	-.1096
-.1007		
		.0287
		.0414
	-.2034	.1518
-.1642		.2957
-.1598	.1267	
-.3308		.2002
		.1427
.1276	-.3481	
.0889		.0888
	.0404	.0410
.2200		
	.1067	.0214
		.0537
.0710		

Table 10. Multiple regression predictor weights for 1958-1960 differential predictions of thirty-six criteria of academic success at the Washington State University.

Criterion No.	Measures	Number of Cases	Predictor Weights: High School English	High School Mathematics	High School Foreign Languages	High School Social Sciences
			Predictor Measures: 1	2	3	4
1.	All Univ.	2031	.0108	.0088	.0040	.0113
2.	Accounting	356		.0179	.0092	
3.	Anthro.	907		.0102	.0104	.0158
4.	Arch. Eng.	69				.0434
5.	Art	581				.0145
6.	Bact.	681		.0199	.0132	.0115
7.	Biology	545	-.0240	.0189	.0053	.0338
8.	Botany	512		.0213		.0044
9.	Bus. Admin.	450	.0071	.0078	.0066	.0074
10.	Chemistry	1029		.0154	.0066	
11.	Economics	790		.0034	.0051	.0132
12.	Drama	140	.0209		.0050	
13.	Education	646	.0201	.0036		.0178
14.	Engineer.	446		.0103		
15.	Eng. Comp.	451	.0178	.0074	.0040	
16.	Eng. Lit.	846	.0189	.0080		.0115
17.	Forestry	53	.0662		-.0125	
18.	Geography	611	.0181		.0020	.0189
19.	Geology	627		.0189	-.0074	.0108
20.	History	1008	.0074	.0062		.0138
21.	Journalism	125			.0279	
22.	Home Econ.	395	.0199		.0086	
23.	Language	332		.1064	.2326	-.0568
24.	Math.	1118	.0082	.0210		
25.	Music	682		-.0748	.1106	.0739
26.	Nursing	51	-.0291	.0210		.0566
27.	Nutrition	188	.0254		.0106	
28.	Pharmacy	30	.0565	-.0375	-.0134	
29.	Philosophy	531	.0158		.0040	.0095
30.	Physics	245				
31.	Pol. Sci.	635		.0147		.0201
32.	Psychology	1300		.0180	.0044	.0169
33.	Radio/TV	51		-.0674	.0334	
34.	Sociology	1403		.0072		.0265
35.	Speech	766	.0296		.0080	
36.	Zoology	676	-.1050	.1613	.1823	

Predictor Weights						
Predictor Measures						
High School Natural Science	High School Electives	G. - Z. Verbal	G. - Z. Mechanical	English Usage	Spelling	Mathematics
5	6	7	8	9	10	11
.0129	.0149	.0049	-.0030	.0018	-.0046	
.0155	-.0127		.0079	-.0027	-.0068	.0219
.0142		.0079	-.0041			-.0034
-.0179	.0258	-.0264		.0099	-.0140	.0284
.0169	.0090	.0065			-.0039	-.0054
.0258		.0089				
.0213			.0043	.0023		
.0265	.0143	.0080	-.0069			.0198
.0109		.0062		-.0033	-.0034	
.0293			-.0124		.0028	.0160
.0129			.0071			.0086
-.0069	.0078			.0040	-.0128	.0178
.0115					-.0110	
.0141	.0198	-.0082	.0118	.0052	-.0060	-.0132
.0055	.0122		-.0032		.0062	
	.0081	.0040		.0026	-.0096	
		-.0277	.0092	.0078		-.0193
			.0039	-.0053		.0063
.0114				-.0025	-.0103	.0175
.0084					-.0081	
	.0281	.0083	.0092	.0054		-.0220
.0143	.0179	.0104		.0028	.0155	-.0105
			-.2278	.0792	.0680	
.0115			-.0126	-.0017	-.0027	.0194
	.0821	.1169				
		-.0109	.0108	.0045	.0187	
.0139	.0133				-.0064	.0023
			.0130		.0078	.0290
.0322		.0027	-.0057	.0022		.0030
.0372	-.0178	.0068	.0042	.0072	-.0037	
.0169		.0034	-.0036	-.0036		
.0153	-.0050	.0104			-.0050	
	.0321		.0257	-.0088	.0219	.0387
.0056	.0074	.0131		.0019	-.0069	.0027
	.0086	.0169		.0074	-.0398	
.2165	.0540	-.0643			.0660	

Table 10. Continued.

Criterion No.	Measures	Number of Cases	Predictor Measures: Social Studies	A.C.E.-Q	Age
			12	13	14
1.	All Univ.	2031	.0116		.0317
2.	Accounting	356		.0074	
3.	Anthro.	907	.0164		
4.	Arch. Eng.	69		-.0083	-.3871
5.	Art	581		.0105	.0554
6.	Bact.	681	-.0107	-.0068	-.0705
7.	Biology	545	.0142	-.0036	
8.	Botany	512		-.0040	-.0412
9.	Bus. Admin.	450	.0083	.0109	
10.	Chemistry	1029	.0180		-.0262
11.	Economics	790	.0165		
12.	Drama	140		-.0142	
13.	Education	646	.0111	.0034	
14.	Engineer.	446	.0094		
15.	Eng. Comp.	451		-.0063	.1100
16.	Eng. Lit.	846	.0081	-.0064	
17.	Forestry	53	.0216		-.1764
18.	Geography	611	.0142		
19.	Geology	627		.0051	-.0505
20.	History	1008	.0211	-.0036	-.0649
21.	Journalism	125	.0093		
22.	Home Econ.	395	.0077		
23.	Language	332	.1158		-.0247
24.	Math	1118		.0025	
25.	Music	682	-.0815	.1153	
26.	Nursing	51	-.0181		
27.	Nutrition	188	.0180	.0048	
28.	Pharmacy	30			-.4674
29.	Philosophy	531	.0108		
30.	Physics	245	.0066	.0071	
31.	Pol. Sci.	635	.0175		
32.	Psychology	1300	.0202		-.0350
33.	Radio/TV	51	.0387	.0374	-.0182
34.	Sociology	1403	.0173	-.0042	.0376
35.	Speech	766		.0025	-.0209
36.	Zoology	676		.0366	.0722

Predictor Measures				
Sex	A.C.E.-L	Coop - Speed	Coop - Level	
15	16	17	18	Regression Constants
			.0103	-.68488
.4077				.61744
-.3311		.0070		.57207
.2921				7.55245
-.1381	.0047			-.49290
-.2430		.0076		1.71129
		.0043		.23202
-.3420				.91035
				.75202
-.2372		-.0046		.90485
.2403	.0046	.0102		.71889
.1087	-.0023			2.17504
.1885		.0064	.0063	.53078
.3392				.68321
		.0080		-.62547
-.1180	.0039	.0047		.85946
	.0331		.0242	1.99790
.0435	.0035	.0076		.88507
	.0061	.0127		1.39189
	.0047	.0093		1.83797
-.3145		.0147	-.0169	.50397
	-.0055			.41265
-.0646			.0287	1.69675
.2228			.0069	.65697
-.0616		-.2034	.1517	1.97221
	-.0095		.0452	.86913
	-.0092	.0104		.49910
.6993	-.0186		.0297	10.04656
			.0238	.69455
	.0078	-.0300		.61195
.0682	.0054		.0142	.17572
-.1250		.0037	.0070	.96284
-.1691	.7536	-.0122		5.62997
-.0677		.0090	.0033	-.47507
.0957			.0076	.81135
.0710				-.46000

Table 11. Comparison of simple correlation coefficients, Z-transformation of correlations and t values of significance for W.P.C.T.P. predicted grades and Washington State University predicted grades when correlated with achieved grades for 1961 freshmen at Washington State University.

Criterion Area	W.S.U.	Z Trans.	W.P.C.T.P.	Z Trans.	t Value
All-University	.65	.738	.66	.744	Not Sig.
Accounting	.43	.406	.45	.409	Not Sig.
Anthropology	.59	.671	.59	.671	Not Sig.
Architecture	.57	.648	.36	.377	.01
Art	.42	.448	.36	.377	.05
Bacteriology	.42	.448	.46	.491	Not Sig.
Biology	.51	.563	.56	.633	.05
Botany	.59	.671	.43	.460	.01
Business Admin.	.42	.448	.41	.436	Not Sig.
Chemistry	.52	.576	.53	.590	Not Sig.
Economics	.47	.510	.49	.536	Not Sig.
Drama	.22	.224	.32	.332	.01
Education	.49	.536	.51	.563	Not Sig.
Engineering	.44	.472	.38	.400	.05
English Comp.	.41	.436	.39	.412	Not Sig.
English Lit.	.50	.549	.46	.497	Not Sig.
Forestry	.40	.424	.22	.224	.01
Geography	.51	.563	.51	.563	Not Sig.
Geology	.46	.497	.39	.412	.05
History	.50	.549	.51	.563	Not Sig.
Journalism	.42	.448	.23	.234	.01
Home Economics	.47	.510	.49	.536	Not Sig.
Language	.47	.510	.50	.549	Not Sig.
Mathematics	.48	.522	.46	.497	Not Sig.
Music	.13	.131	.05	.050	Not Sig.
Nursing	.46	.497	.59	.671	Not Sig.
Nutrition	.56	.637	.53	.590	Not Sig.
Pharmacy	.38	.400	-.16	.161	.01
Philosophy	.41	.436	.45	.485	Not Sig.
Physics	.40	.430	.34	.354	.05
Political Sci.	.46	.497	.50	.549	Not Sig.
Psychology	.52	.575	.54	.604	Not Sig.
Radio & TV	.49	.536	.45	.485	Not Sig.
Sociology	.60	.693	.59	.671	Not Sig.
Speech	.48	.522	.46	.497	Not Sig.
Zoology	.48	.522	.46	.497	Not Sig.

The criterion areas Architecture, Art, Biology, Forestry, Journalism, Nursing and Pharmacy are special areas at Washington State University inasmuch as they are separate schools with small enrollments or somewhat different curriculum than similarly named departments at the University of Washington. The differences in Botany, Drama, Engineering, Geology, and Physics are not so readily explained.

In summary the grade predictions used in the Washington Pre-College Testing Program correlate with achieved grades of students at Washington State University as well as did the grade prediction developed using normative data from Washington State University except in the prediction areas of Architecture, Art, Biology, Botany, Drama, Engineering, Forestry, Geology, Journalism, Nursing, Pharmacy and Physics.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The increasing number of students desiring the opportunity of higher education has not only increased demands on institutions of higher education but has created problems in the assessment of students and institutions. One primary assessment problem is admissions requirements and subsequent student academic performance in the classroom. Faculty and student personnel workers must obtain the best possible estimate of the student's academic potential and limitations and must use this information in working with the student. Assessment of the individual student and the total student group must be integrated with a comprehensive understanding of the institution to provide for an effective utilization of the resources of higher education and the nation.

The total student personnel program of an institution of higher education includes the use of psychological testing for the study of student aptitudes and achievements. Recognizing that these tests are only part of a total program, college student services personnel and faculty are able to plan effectively a total and valid program. The wide variety of available tests, the varying techniques for

presentation of data on students, and the existing differences among students and between institutions present a bewildering problem in subsequent use of test data for assessment and admissions.

Purpose

The advent of the Washington Pre-College Testing Program led to an evaluation of the state-wide testing program at Washington State University and the use of grade predictions from the state-wide program. The Washington Pre-College Testing Program was developed at the University of Washington and had as its primary basis the use of predicted grades in collegiate academic areas as indices of academic performance. The predicted grades are formulated from normative data at the University of Washington.

The basic question of this study is whether a predicted college grade from the Washington Pre-College Testing Program for a certain academic area is applicable to students at Washington State University. Are the multiple regression formulas, predictor beta weights, and the basic normative data applicable for the best prediction of students' grades at Washington State University? Specifically four questions with related hypotheses were asked:

1. Students' aptitudes and achievements, as measured by high school grades and testing data on the Washington Pre-College Testing Program, were inspected to determine what similarities or differences existed between the two normative groups in this study.

2. How accurate are the current predicted grades of the Washington Pre-College Testing Program for students at Washington State University at various levels of progress, i.e., freshman, sophomore, or senior? Can the grade predictions be used to predict grades equally well at all three levels?

3. Is there a hierarchy in the subject matter areas as represented by the predicted and achieved grades from the Washington Pre-College Testing Program and what similarity does this hierarchy have to the predicted and achieved grades for students at Washington State University?

4. A null hypothesis was made in each of the 36 criterion areas between grade predictions from the Washington Pre-College Testing Program and grade prediction derived from normative data at Washington State University when correlated with the achieved grades for students at Washington State University at the cumulative freshman-junior level. The differences in prediction would be such that no new prediction formulas were necessary for prediction studies at Washington State University.

Procedure

The data used in the study were available on punched cards for the test scores and high school grades and on computer magnetic tape for the college grades. The 1958-1960 freshmen at Washington State University, for whom a complete and valid record of data from the Washington Pre-College Testing Program was available, were used as a normative group to derive the correlation matrix for the predictor variables and the predictor-criterion matrix. The 1961 freshmen group at Washington State University were used for certain correlation data in the study.

The two matrices were used with the Horst multiple regression or iteration program for the computation of the corrected multiple correlation coefficients (R's) between the predictors and the criteria of student achieved grades

at Washington State University. The predictor weights from the computation of the multiple R's were substituted into the IBM 709 computer program for the present Washington Pre-College Testing Program and new predictions were developed. The new predictions were compared with the predictions from the Washington Pre-College Testing Program as to correlations with achieved grades. The 1961 freshmen at Washington State University were used as a cross-validity sample; the criteria of comparison were the achieved grades of the 1961 freshmen through the academic years of 1961-1964.

Findings

The two normative groups in the study were comparable and similar for the purpose of the study. Inspection of student test scores and high school grades showed marked similarity for the two groups; the few differences noted were attributable to the differing ratio of male to female students in the two universities.

The grade predictions from the Washington Pre-College Testing Program, when correlated with the achieved grades at the cumulative freshman, cumulative freshman and sophomore and cumulative freshman-junior levels, showed no significant differences except that there was a higher correlation at the cumulative freshman level for All-University, Art, and Bacteriology.

A rank correlation coefficient of .88 between the predicted grades for the normative groups of the two institutions showed that a hierarchy exists when ranking the

predicted grades from high to low. The two criterion areas of English Composition and Economics accounted for most of the deviation from complete correlation. A rank-correlation of .57 between the achieved grades of the two normative groups showed a greater variation exists in achieved than in predicted grades. A comparison of the ranking of the predicted grades with the ranking of the achieved grades for the 1961 freshmen at Washington State University showed a rank-correlation of .57.

The predictions derived from multiple iteration procedures of the criteria of grades at Washington State University did not improve the correlations with achieved grades over the predicted grades from the Washington Pre-College Testing Program except for the criterion areas of Architecture, Art, Biology, Engineering, Forestry, Geology, Journalism, Pharmacy, and Physics. The prediction formulas now used in the present Washington Pre-College need not be changed except in the cases noted.

Conclusions

It is not necessary to develop for Washington State University students multiple regression formulas different from those used in the Washington Pre-College Testing Program except for certain criterion areas. These criterion areas are for the most part special curriculum areas or programs at Washington State University. Empirical research has shown that similarly named criterion areas at different

institutions may or may not be predicted by the same statistically derived formula and that the application of the grade predictions from the Washington Pre-College Testing Program to other institutions and student groups must be validated by research.

The grade predictions from the Washington Pre-College Testing Program can be used to predict cumulative freshman grades as well as the previously recommended total cumulative grades. The general acceptance of a null hypothesis for differences among the three levels of achieved grades (cumulative freshman, cumulative freshman and sophomore, and cumulative freshman-junior), when correlated with the predicted grades, makes it possible to use the cumulative freshman grades as a criteria for the prediction procedure rather than using the criteria of the cumulative four year grades. The resulting saving in time and the more immediate validation procedure for introduction of new testing data or criteria make such a procedure a recommendation in future normative studies.

The hierarchy among the predicted and achieved grades in the Washington Pre-College Testing Program reflects the concept of differential prediction and the differences in grading practices of departments within the university. A clear perception of such a hierarchy can be of help in the understanding of differential prediction and the predicted grades from the Washington Pre-College Testing Program. The similarity of the student groups from Washington State

University and University of Washington when compared on the predictor variables in the Washington Pre-College Testing Program, and the similarity of the grading practices as compared on the predicted grades, demonstrate the student populations and grading practices are much the same and, therefore, the prediction formulas can be used equally well for both groups.

Recommendations

1. The predicted course grades in the Washington Pre-College Testing Program should be redefined in other than the established criterion areas. Summarization by varying levels of course work or curriculum within a criterion area, rather than by all courses within the criterion area, might more sharply define sampling and grading differences.

2. Decisions as to further reductions in the number of prediction areas should be made on the basis of empirical analysis of the similarity or prediction statistics and on practical considerations from counselors and research workers. The present use of criterion areas from only one university and the grouping of courses into criterion areas as defined in that university's bulletin ignores other curriculum or programs.

3. Predictions should be made for general areas, primarily for general courses taken during the freshman year. For example, many freshman students are interested in social science as a general area but lack the information

necessary to differentiate between such specific fields as sociology or psychology.

4. The predictions in the criterion areas of Music, Art, Drama, and Radio and Television should be dropped from the testing program because of the low multiple correlation in prediction and the difficulty in prediction in these areas from the types of tests in the present test battery. The continued use of predictions in these areas can lead only to further misunderstanding and erroneous conclusions concerning prediction validity.

5. The prediction formulas used in the Washington Pre-College Testing Program should be based upon one year achievement grades rather than four year extent of achievements. Certain exceptions may be necessary such as criterion areas where the necessary grades are not available until the second or third year.

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APPENDICES

APPENDIX A

ENTRANCE DATA 1958-1960 FRESHMEN - WASHINGTON STATE UNIVERSITY
SYMMETRIC CORRELATION MATRIX 0046 - 18 x 18

	1 Eng. GPA	2 Math. GPA	3 For. Lang. GPA	4 S.Sci. GPA	5 N.Sci. GPA	6 Elect. GPA	7 G.Z. Verb.	8 G.Z. Mech.	9 OM Usage
1. H.S. English GPA	1.0000	.6214	.7059	.7612	.6721	.5510	.4102	-.2900	.6004
2. H.S. Math. GPA		1.0000	.6350	.5920	.6587	.4801	.2821	.0115	.4583
3. H.S. For. Lang. GPA			1.0000	.6478	.6323	.4855	.3184	-.1818	.5027
4. H.S. Soc. Sci. GPA				1.0000	.6672	.4961	.3899	-.1721	.4594
5. H.S. Nat. Sci. GPA					1.0000	.4791	.3359	-.0423	.4502
6. H.S. Elect. GPA						1.0000	.1654	-.1302	.3602
7. G.Z. Verbal							1.0000	.0241	.5567
8. G.Z. Mech. Know.								1.0000	-.1908
9. Coop. O.M. Usage									1.0000
10. Coop. O.M. Spell.									
11. Coop. Math									
12. Coop. Soc. Stu.									
13. A.C.E. - Q.									
14. Age									
15. Sex									
16. A.C.E. - L.									
17. Coop. Read. Speed.									
18. Coop. Read. Level									

Appendix A. Continued.

	10 OM Spell.	11 Coop. Math.	12 Coop. S.S.	13 ACE Q	14 Age	15 Sex	16 ACE L	17 Coop. Read. Speed.	18 Coop. Read. Level
1. H.S. English GPA	.5124	.2113	.3302	.2338	-.0859	.3777	.4259	.4001	.3337
2. H.S. Math. GPA	.3259	.5003	.3261	.4370	-.0513	.0716	.3376	.3416	.3171
3. H.S. For. Lang. GPA	.4573	.2696	.2559	.2302	-.0665	.2548	.3348	.3102	.2621
4. H.S. Soc. Sci. GPA	.3895	.2741	.3678	.2485	-.0688	.2136	.4060	.4029	.3371
5. H.S. Nat. Sci. GPA	.3377	.3334	.3320	.2868	-.0632	.1690	.3655	.3508	.3048
6. H.S. Elect. GPA	.2844	.1644	.1612	.1946	-.0522	.2421	.2141	.1888	.1514
7. G.Z. Verbal	.5193	.3711	.6240	.3008	-.0125	.0832	.7448	.6531	.5917
8. G.Z. Mech. Know.	-.2160	.4480	.1591	.2254	.1063	-.7567	.0611	.0586	.1035
9. Coop. O.M. Usage	.6385	.3305	.4603	.3885	-.1045	.3201	.6016	.5459	.4887
10. Coop. O.M. Spell.	1.0000	.2178	.3402	.2628	-.0773	.2835	.5103	.4500	.3569
11. Coop. Math		1.0000	.4812	.6287	-.0380	-.4103	.4464	.4094	.4125
12. Coop. Soc. Studies			1.0000	.4306	-.0352	-.0648	.6311	.6390	.5735
13. A.C.E. - Q.				1.0000	-.0978	-.2018	.5042	.4638	.3811
14. Age					1.0000	-.0800	-.0774	-.0850	.0378
15. Sex						1.0000	.0554	-.3628	.0502
16. A.C.E. - L.							1.0000	.6982	.5798
17. Coop. Read. Speed.								.4060	.4052
18. Coop. Read. Level									.8015

APPENDIX B

NON-SYMMETRIC MATRIX OF 18 PREDICTOR VARIABLES WITH 36 CRITERION AREA VARIABLES FOR THE 1958-1960 FRESHMEN CLASSES AT WASHINGTON STATE UNIVERSITY

		All-Univ.	Accounting	Anthro.	Arch.	Art	Bact.	Biology
1.	H.S. English GPA	.5438	.2780	.3581	.2123	.3038	.3582	.3240
2.	H.S. Math GPA	.4862	.4004	.3782	.3785	.2799	.4002	.4004
3.	H.S. For. Lang. GPA	.4755	.2985	.3614	.1993	.2790	.3806	.3461
4.	H.S. Soc. Sci. GPA	.5281	.2724	.4063	.3650	.3309	.3787	.4180
5.	H.S. Nat. Sci. GPA	.5160	.3508	.3944	.2288	.3404	.4210	.4164
6.	H.S. Elect. GPA	.4159	.1541	.2346	.3234	.2318	.2707	.2275
7.	G.Z. Verbal	.3801	.1611	.3514	-.0480	.2661	.2471	.2579
8.	G.Z. Mech. Know.	-.0993	.0938	.0576	.1054	.0740	-.0037	.0533
9.	Coop. O.M. Usage	.4449	.1909	.2888	.2478	.2192	.2529	.2951
10.	Coop. O.M. Spelling	.3162	.1038	.2272	.0186	.1629	.1995	.2006
11.	Coop. Math.	.2823	.3624	.2998	.4046	.2281	.2451	.2716
12.	Coop. Soc. Studies	.3801	.2181	.3749	.1278	.2536	.1892	.3115
13.	A.C.E. - Q.	.2696	.2919	.2579	.2532	.2721	.1653	.2168
14.	Age	-.0251	-.1570	-.0110	-.3657	.0198	-.0708	-.0302
15.	Sex	.1585	.0244	-.0563	-.1658	-.0304	-.0054	.0086
16.	A.C.E. - L.	.3877	.2088	.3550	.0841	.2995	.2570	.2698
17.	Coop. Read. Speed	.3804	.2324	.3592	.1262	.2491	.2485	.2937
18.	Coop. Read. Level	.3585	.1624	.3080	.1529	.1979	.2148	.2379

Appendix B. Continued.

	Botany	Bus. Admin.	Chem.	Econ.	Drama	Education	Engl. Comp.
1. H.S. English GPA	.3316	.2711	.3516	.3245	.2468	.4651	.4018
2. H.S. Math GPA	.4285	.3009	.4365	.3305	.1512	.3735	.3075
3. H.S. For. Lang. GPA	.3157	.2638	.3710	.3104	.2087	.3572	.3432
4. H.S. Soc. Sci. GPA	.3434	.3890	.3709	.3498	.1983	.4606	.3446
5. H.S. Nat. Sci. GPA	.4073	.3009	.4397	.3580	.1627	.4249	.3232
6. H.S. Elect. GPA	.2709	.1712	.2441	.1895	.1862	.2975	.2975
7. G.Z. Verbal	.2571	.2093	.2450	.2833	.0888	.2903	.2222
8. G.Z. Mech. Know.	.0970	.0156	-.0064	.0346	-.0685	-.0982	-.1445
9. Coop. O.M. Usage	.2506	.1704	.2953	.2818	.1820	.3302	.2982
10. Coop. O.M. Spell.	.1760	.1324	.2432	.2358	.0398	.1934	.2876
11. Coop. Math.	.3917	.2235	.3603	.2707	.1241	.1707	.0898
12. Coop. Soc. Studies	.2790	.2343	.3151	.3272	.1009	.3085	.1656
13. A.C.E. - Q.	.2691	.2430	.2770	.2201	-.0195	.2096	.0814
14. Age	-.0529	-.0354	-.0622	-.0623	-.0060	-.0293	.0562
15. Sex	-.0991	.0132	-.0094	.0773	.1103	.2006	.1609
16. A.C.E. - L.	.2580	.2391	.2669	.2696	.0598	.2811	.2038
17. Coop. Read. Speed	.2491	.2150	.2510	.3251	.0958	.3340	.2357
18. Coop. Read. Level	.2298	.1600	.2312	.2536	.0928	.2960	.1947

Appendix B. Continued.

	Eng. Lit.	Forestry	Geog.	Geology	History	Journal-ism	Home Ec.	Lang.
1. H.S. English GPA	.3701	.5417	.3161	.2098	.3455	.3600	.4233	.3565
2. H.S. Math. GPA	.3177	.3538	.2652	.3401	.3151	.3171	.3665	.3202
3. H.S. For. Lang. GPA	.2862	.3323	.2574	.1756	.2749	.4048	.3858	.3979
4. H.S. Soc. Sci. GPA	.3642	.4039	.3552	.2529	.3741	.3652	.3998	.2991
5. H.S. Nat. Sci. GPA	.3249	.3904	.2898	.2819	.3444	.3492	.4248	.3005
6. H.S. Elect. GPA	.2520	.3684	.1729	.1248	.1960	.3398	.3505	.2335
7. G.Z. Verbal	.2885	.2591	.2639	.2143	.3268	.3199	.2740	.2459
8. G.Z. Mech. Know.	-.0215	-.1237	.0689	.1660	.0238	.0816	.0373	-.2220
9. Coop. O.M. Usage	.3002	.4981	.1751	.1538	.2680	.3553	.3213	.3548
10. Coop. O.M. Spell.	.1737	.4052	.1631	.0549	.1805	.2860	.1487	.3202
11. Coop. Math.	.1857	.0950	.2592	.3724	.2565	.1597	.2856	.1171
12. Coop. Soc. Studies	.2889	.2018	.3207	.2413	.3888	.2936	.2783	.2341
13. A.C.E. - Q.	.1599	.2398	.2062	.3035	.2134	.2155	.2346	.1455
14. Age	-.0421	-.1952	-.0102	-.0602	-.0919	.0176	-.0144	-.0795
15. Sex	.0424	.2357	-.0124	-.1058	.0216	-.0123	.0355	.2024
16. A.C.E. - L.	.2990	.4755	.2944	.2536	.3529	.3012	.2431	.2500
17. Coop. Read. Speed	.2916	.3299	.3078	.2477	.3708	.3247	.2754	.2298
18. Coop. Read. Level	.2619	.3272	.2629	.2473	.3095	.2388	.2194	.2108

Appendix B. Continued.

	Math	Music	Nursing	Nutrition	Pharmacy	Philosophy	Physics
1. H.S. English GPA	.3559	.1427	.3179	.4331	.3533	.2966	.2380
2. H.S. Math. GPA	.3837	.1093	.4210	.3767	.0616	.3033	.2299
3. H.S. For.Lang. GPA	.3196	.1545	.3723	.3904	.1540	.2992	.2496
4. H.S. Soc. Sci. GPA	.3155	.1427	.4542	.3847	.1872	.3254	.2067
5. H.S. Nat. Sci. GPA	.3399	.1016	.3974	.4144	.1795	.3798	.3346
6. H.S. Elect. GPA	.2428	.1353	.2777	.3298	.1617	.1979	.0904
7. G.Z. Verbal	.1785	.1091	.1642	.2489	.1757	.2953	.1998
8. G.Z. Mech. Know.	-.1782	.0222	.0770	-.0452	-.1567	-.0474	.0473
9. Coop. O.M. Usage	.2658	.0856	.3230	.3073	.2842	.3182	.2746
10. Coop. O.M. Spell.	.2008	.0952	.3100	.1949	.2578	.2197	.1503
11. Coop. Math.	.2200	.1006	.2499	.2306	.1149	.2208	.2038
12. Coop. Soc. Studies	.1725	.0461	.1581	.2964	.1525	.3028	.1827
13. A.C.E. - Q.	.1997	.1187	.1571	.2258	.0996	.1992	.1895
14. Age	-.0627	-.0270	-.0018	-.0537	-.4246	-.0352	-.0114
15. Sex	.2024	-.0201	.0378	.1156	.3154	.0832	.0362
16. A.C.E. - L.	.1836	.0768	.1792	.2165	.0980	.2863	.2284
17. Coop. Read. Speed	.1856	.0465	.2954	.2938	.2151	.3306	.0621
18. Coop. Read. Level	.1906	.0973	.3440	.2107	.2392	.3213	.1178

Appendix B. Continued.

	Pol. Sci.	Psychology	Radio & TV	Sociology	Speech	Zoology
1. H.S. English GPA	.4038	.3659	.1385	.4189	.4003	.3236
2. H.S. Math GPA	.3883	.4012	-.1484	.3765	.3008	.4189
3. H.S. For. Lang. GPA	.3494	.3355	.1775	.3440	.3143	.3971
4. H.S. Soc. Sci. GPA	.4341	.4009	.0680	.4589	.3605	.3516
5. H.S. Nat. Sci. GPA	.4165	.4001	.0642	.3931	.3278	.4213
6. H.S. Elect. GPA	.2630	.2056	.1792	.2692	.2709	.2316
7. G.Z. Verbal	.3349	.3673	.1778	.4464	.3022	.2564
8. G.Z. Mech. Know.	-.0586	.0446	.1263	-.0011	-.0672	.0190
9. Coop. O.M. Usage	.2922	.3142	.0209	.3787	.3470	.3008
10. Coop. O.M. Spell.	.2343	.2193	.2101	.2611	.2138	.2296
11. Coop. Math.	.2349	.3189	.1513	.3171	.1724	.2967
12. Coop. Soc. Studies	.3594	.3998	.2332	.4454	.2455	.2502
13. A.C.E. - Q.	.2146	.2845	-.0924	.2526	.1715	.2438
14. Age	-.0444	-.0522	-.1220	-.0041	-.0506	.0019
15. Sex	.1143	-.0216	.0915	.0298	.1541	.0095
16. A.C.E. - L.	.3527	.3498	.0596	.4187	.2694	.2802
17. Coop. Read. Speed	.3548	.3707	.1707	.4396	.2552	.2504
18. Coop. Read. Level	.3244	.3420	.1797	.3945	.2686	.2238

APPENDIX C

UNIVERSITY OF MINNESOTA
OFFICE OF EDUCATIONAL RESEARCH
211 BURTON HALL

INTERPRETATION OF N. FATTU'S NOMOGRAPH - January 21, 1946

Purpose:

To test hypothesis that two observed proportions, p_1 and p_2, obtained from samples of size N_1 and N_2 are consistent with sampling from a common population.

On this hypothesis, $p_1 - p_2$ is $\bar{p}_1 - \bar{p}_2 = 0$, hence wish to test if observed difference is significantly greater than zero. The standard deviation of the difference (with zero correlation between proportions) is

$$S_{(p_1 - p_2)} = \sqrt{s^2_{p_1} + s^2_{p_2}} = \left(\frac{pq}{N_1} + \frac{pq}{N_2}\right)^{1/2} = (pq)^{1/2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)^{1/2}$$

Since $p = \bar{p}_1 = \bar{p}_2$ is unknown, it must be estimated in order to evaluate. Theoretical considerations indicate that a good estimate is the weighted mean of the two p's, or

$$p^1 = \frac{N_1 p_1 + N_2 p_2}{N_1 + N_2}$$

The t-ratio becomes,

$$t = \frac{p_1 - p_2}{\left(\frac{N_1 p_1 + N_2 p_2}{N_1 + N_2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)^{1/2}} = \frac{p_1 - p_2}{(p_1 + p_2)^{1/2}\frac{2}{n}}$$

By suitable algebraic manipulation of the formula it is possible to make a chart with a fixed N_1 and N_2.

However, it is much easier to make a computing chart if one uses Fisher's transformation of proportions, t = 2 arc sine $\sqrt{p}$ as Zubin[1] did.

The standard error of the transformed proportion, t, is $\sqrt{\frac{1}{N}}$; hence the standard error for the difference becomes

$$S_{(t_1 - t_2)} = \sqrt{S_{t_1}^2 + S_{t_2}^2} \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$$

Whence the t-ratio becomes,

$$\text{t-ratio} = \frac{t_1 - t_2}{\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}} = \frac{T}{D}$$

I prepared the Committee nonograph in 1939 because the two that Zubin had were too small and too cumbersome for practical use. Reference from one to the other also introduced another possible source of error.

The trick was accomplished by calibrating the scales p_1 and p_2 in terms of the arc sine transformation units. From p_1 and p_2 it would therefore be possible to read $T = t_1 - t_2$ directly. (This is accomplished by joining p_1 and p_2 by means of a hair line. The required value of T is given by the reading at the point where the hair line crosses the vertical T-scale. Similarly, connecting N_1 and N_2 by means of a hair line gives the reading, $D = \sqrt{\frac{1}{N_1} + \frac{1}{N_2}}$, at the point where the hair line crosses the vertical D-scale.)

To facilitate the computation of tests of significance, the T values were divided by 1.96 for the .05 level and 2.58 for the .01 level. A test of significance then is made by comparing the D with the T values. If the values of $D \leq T_{.05}$, the difference is significant at .05 level. If the value of

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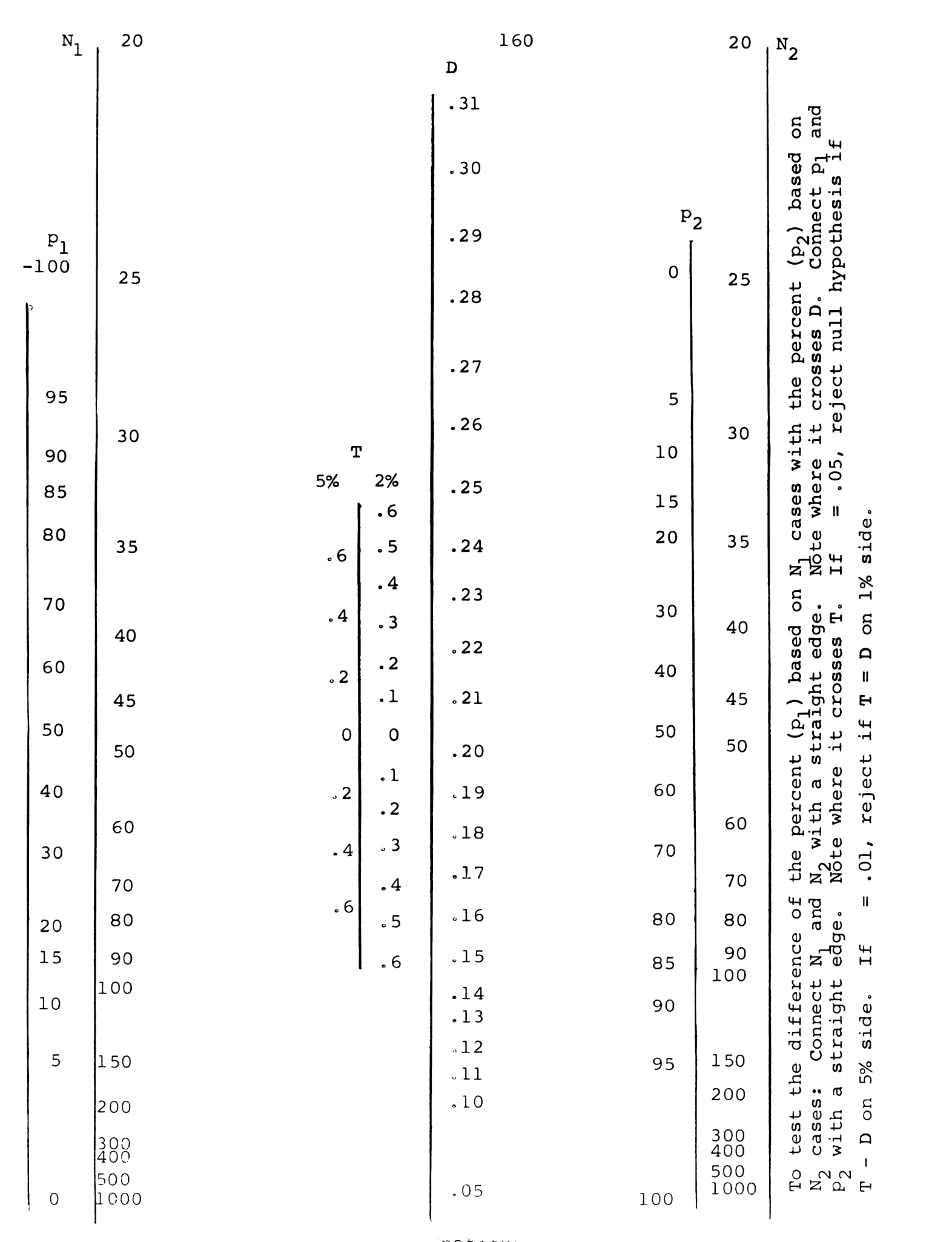
[1] J. Zubin, "Nonographs for Determining the Significance of the Differences between the Frequencies of Events in Two Contrasted Series or Groups," Journal of American Statistical Association, 34:539-544, 1939.

$D < T_{.01}$, the difference is significant at the .01 level.

To find the actual t-ratio multiply the $T_{.05}$ value by 1.96 and divide by D, or multiply the $T_{.01}$ value by 2.58 and divide by D.



To test the difference of the percent (p_1) based on N_1 cases with the percent (p_2) based on N_2 cases: Connect N_1 and N_2 with a straight edge. Note where it crosses D. Connect p_1 and p_2 with a straight edge. Note where it crosses T. If T - D on 5% side. = .05, reject null hypothesis if = .01, reject if T = D on 1% side.